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STAR WARS AT THE CROSSROADS:

THE STRATEGIC DEFENSE INITIATIVE AFTER FIVE YEARS

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EXECUTIVE SUMMARY

The SDI program has reached a conceptual and financial crossroads. The once grand dream of a world protected by defensive weapons has evaporated in the sunlight of technological reality. The President's elegantly simple concept has metamorphosed into a classic weapons development program.

Ridding the world of the threat of nuclear weapons is now a fading vision. The SDIO's official insignia, an orbiting shield, no longer represents an impenetrable umbrella of population protection so much as a porous adjunct to current deterrence theory. No longer will SDI technology be shared with the Soviet Union, as advocated by the President, to replace the balance of terror with the stability of mutual defense.

Perhaps it was inevitable that such changes would take place. All visions necessarily change when they emerge from five years of real world scrutiny. Seldom has such a revolutionary proposal mutated so drastically, but seldom has a President sought to overturn the doctrinal foundation of our national security.

The President's intellectual challenge now lies victim as much to its allies as to its critics. In part this is a normal consequence of "fleshing out" a new initiative. In part it represents an attempt to glean something feasible from the vision and incorporate it into current military doctrine.

In our review we found a team of engineers, scientists and strategic planners unexcelled in breadth and depth of expertise. Not since the Manhattan project has so much talent been focused so broadly on so many technological challenges. For sheer magnitude of effort, SDI dwarfs any other scientific research and development program in history.

The high costs of this effort make it essential that Congress and the American public understand the factual basis of the SDI program, carefully winnowing out the hyperbole, the exaggerated criticism, and the self-serving statements of proponents and opponents alike.

The Administration's push for a deployment capability beginning in the mid-1990's -- the emphasis last year on an "early deployment" -- has stalled. Both contractors and SDI officials privately told us "We're no longer pursuing early deployment," and, "Early deployment is dead."

In 1986 SDIO provided an original time frame for deployment at the turn of the century. In 1987 the time frame was accelerated to the mid-1990's. Now the program has come full circle and, although SDIO refuses to provide a precise date, we believe initial deployment of SDI's first phase (Phase I) will be delayed until 1998 at the earliest with full operational capability three years later. Even this is extraordinarily optimistic because it assumes the availability of space launch vehicles, substantial real growth year after year in the SDI budget, and no major technological delays.

The Advanced Launch System (ALS), which is critical to placing Phase I in space at affordable cost, will not be available at least until the year 1998. That date is likely to slip, as the Administration has scaled back the program to a technology development effort. One driving factor in designing ALS is the new requirement for a [ ] pound lift capacity to accommodate a space-based laser.

Phase I will be obsolete the day it is deployed, in our opinion. The likely Soviet use of innovative tactics, offensive proliferation, and other active and passive countermeasures will reduce Phase I effectiveness dramatically.

Even if Phase I meets its operational requirements, it will intercept [ ] of Soviet missile warheads projected by SDIO for [ ]. In the face of likely Soviet countermeasures this would fall [ ]. This is even less effective than our estimate last year.

The START agreement now being negotiated would reduce the [ ] Soviet ballistic missile threat by 65% - 69%. Remarkably, START would be [ ] more effective than Phase I in reducing this threat.

At this time we do not believe that Phase I likely would meet the legal tests of being cost-effective at the margin and survivable.

Phase I at best would provide limited protection for some military targets, but virtually no direct protection for the American population in a nuclear war.

SDI limitations cannot be dismissed as simply due to Congressional budget cuts. In the past five years Congress has provided nearly all the funding (92%) the President's own scientific advisers secretly told him in the landmark Fletcher Report would be adequate for an SDI research program.

SDIO's cost estimate of Phase I through deployment has jumped dramatically in the last year to \$75-\$150 billion. This estimate, derived from contractor data, is a substantial increase over the \$40-\$60 billion projection given to Congress in March of 1987 or even the \$70-\$100 billion claimed by General Abrahamson in September of 1987.

Not covered in these estimates is the cost of research on all other SDI technologies excluded from Phase I. These will total an additional $28 billion before a Phase I development decision is reached. Operation and maintenance would add $10-$21 billion over five years.

Life cycle costs for Phase I, using SDIO figures, could be as high as $171 billion. One national laboratory study has estimated the life cycle costs of a second generation SDI defense at $541 billion. This suggests that the total costs for the first two phases of SDI could approach three-quarters of a trillion dollars.

Just the research for, much less the deployment of, Phase I presumes funding which does not comply with Congressional direction that "future research plans and budgets for SDI must be established using realistic projections of available resources in the overall defense budget...." Other important Department of Defense programs that add to nuclear deterrence and confuse the Soviet war planners will be undercut.

As a result of the high leakage rates envisioned even in the most optimistic assessments of Phase I, SDIO is pushing hard to incorporate a space-based chemical laser into the program as soon as possible. In a dramatic reversal from last year, this laser now is the candidate of choice for shoring up Phase I.

SDIO is emphasizing chemical laser technology at the cost of slipping all other laser and particle beam programs by one year. The major recipient of this reallocation is Zenith Star, a single experiment scheduled for [ ] that will cost $1 - 1.5 billion.

The stretch-out of Phase I deployment and the massive infusion of funding for Zenith Star is blurring the line between Phase I and Phase II. Except for space-based lasers, the practical effect of recent budget decisions is to starve long term technologies to benefit those systems which can be deployed relatively quickly.

SDIO budget decisions for FY 88 and FY 89 have resulted in an 18-24 month delay in the Free Electron Laser (FEL) and a 24 month slippage in the Neutral Particle Beam (NPB). From FY 87 to FY 88, the FEL was cut 15%, NPB 29%, directed energy weapon support programs 41%, while chemical lasers increased 25%. This illustrates the internal reordering of priorities to emphasize space-based lasers.

SDIO understates how much its commitment to Phase I is shortchanging promising new technologies which Congress has said should receive primary emphasis. While SDIO argues that Phase I projects will receive only 14% of SDI funding in the FY 89 request, we believe that Phase I is consuming a minimum of 50% of the budget. If

there were no commitment to pursuing Phase I deployment by the mid-1990's, far-term promising technologies would be enjoying even higher budget allocations.

Most Defense Department programs are well served by emphasizing the threat. Ironically, SDI has a parochial interest in just the opposite -- limiting the scope of the anticipated threat. The Soviet threat assumed by SDIO is not a coordinated intelligence community judgment; its baseline is [ ], several years before Phase I realistically could begin to be deployed; and it assumes that the Soviets make no substantial response to SDI until [ ].

The specter of the Soviet "Red Shield" is often used to justify the SDI program. The Soviets are committing significant resources to ballistic missile defense research but the emphasis is on ground-based systems. There is little evidence of extensive research on the vast array of space-based sensors, weapons and battle management which constitute the multi-layered U.S. concept. We were told if one uses the U.S. definition, there is no Soviet SDI program as such.

After five years and $13 billion in funding -- as much in real dollars as was spent on the Manhattan Project from 1942-1946 -- key national security questions remain. Whether even a limited Phase I deployment would enhance or detract from our national security is an open question. SDIO is assuming that Phase I will be unilateral. Four years ago the Fletcher report raised an alarming scenario of space-based defenses leading to inevitable conflict between the US and USSR. SDIO has yet to resolve these concerns.

If a bolt out of the blue Soviet attack were to occur, there would be no time for a U.S. president personally to authorize the launch of Phase I weapons. Time constraints would force this decision to be made by lower level military officials -- or SDI computers.

While the concept of an Accidental Launch Protection System (ALPS) is attractive enough to merit further study, we find an ABM Treaty-compliant ALPS incompatible with pursuit of Phase I. Countermeasures which the Soviets probably would develop in response to Phase I would easily defeat the more modest ALPS deployment. Even without such a major response to Phase I, Treaty-compliant ALPS deployments would cost on the order of $16 - $37 billion and still fail to completely protect the populous East and West coasts against the plausible spectrum of accidental launch threats.

We find the SDI program in trouble, built on shifting sands, with rationales and justifications changing frequently. The once-clear vision of its purpose has been clouded, even distorted, by new missions and roles. Constantly shifting priorities and unrealistic budget planning have put contractors and national laboratories on a roller coaster of on-again, off-again funding.

The SDI program is embarked on a schedule it cannot achieve, with assumptions of funding that will not be forthcoming. When coupled with significant underestimates of Soviet responses, this is a prescription for financial and military disaster, unless Congress or the next Administration takes remedial action.

PRINCIPAL CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

1. A significant Phase I deployment cannot occur before 1998 at the earliest, with a full operational capability after the turn of the century.

2. Last year's political commitment to an "early deployment" in the mid-1990s has died quietly -- the victim of technological and fiscal reality plus the unavailability of a cost-effective space launch system.

3. A Phase I architecture of kinetic kill space-based interceptors likely would be obsolete the day it is deployed. Technical challenges and the evolving Soviet threat will severely degrade its effectiveness. SDIO is underestimating Soviet political and military resolve and overestimating the difficulty of Soviet countermeasures.

4. Even if Phase I meets its Joint Chiefs of Staff operational requirements, it will intercept [ ] of Soviet missile warheads projected by SDIO [ ]. Phase I primarily would protect selected military assets and would not provide significant direct protection of the American population in the event of a nuclear war.

5. Over the last five years Congress has provided 92% of the funding that SDI scientists told the President in the seminal Fletcher Report would be adequate for an SDI research program in that time period. Congress has provided as much funding for SDI in real dollars as it gave the Manhattan Project in World War II.

6. Unless Congress is prepared to substantially increase funding every year for SDI, there will not be enough resources to carry out a Phase I research program while simultaneously funding an energetic effort for promising new technologies.

7. In the battle for available funding, SDIO is sacrificing research on promising new technologies in favor of its Phase I deployment plan, despite Congressional guidance to the contrary.

8. Surprisingly, the SDIO has not yet seriously addressed _the_ fundamental national security issue: will Phase I deployment and the likely Soviet response result in a net gain or loss for U.S. national security?

9. An Accidental Launch Protection System (ALPS), compliant with the ABM Treaty, would be undermined by pursuit of Phase I deployment because the Soviets likely would adopt countermeasures that would defeat ALPS.

10. While the President's vision of SDI would substitute strategic defenses for nuclear deterrence, SDIO has yet to describe any system, Phase I or otherwise, that would effect such a substitution. Phase I would only reinforce nuclear deterrence.

11. For the first time in over 30 years, during which time the U.S. has developed six different types of SLBMs, the strategic environment is stable enough that the U.S. has no plans to develop a successor to the Trident II SLBM. Soviet development of space-based defenses would overturn this stable environment and require the development of new U.S. SLBMs to maintain a credible deterrent.

Recommendations

1. With Phase I unavailable before the turn of the century, it should be realigned to:

- o emphasize sensor development,
- o reinvigorate the competition among promising new technologies, and
- o focus SBI and ERIS demonstration and validation on lighter and cheaper second-generation approaches.

2. SDIO should explain to Congress how it plans to proceed with its Phase I schedule and conduct a robust technology base program within the limits of realistic projections of available resources.

3. A special independent review team should examine the cost-effectiveness of Phase I and its various components and report to Congress. SDIO should provide input to this review but should not be the sole office involved.

4. In view of the importance of the SDI program, the baseline threat it is designed against - - countermeasures as well as offensive force levels - - should be a coordinated interagency Intelligence Community effort comparable in scope to current National Intelligence Estimates.

5. The Executive Branch should conduct an interagency assessment of the net impact of SDI deployment on U.S. security interests in the

short and long term. Specific attention should be paid to:

- the impact of Soviet SDI deployments co-existing with those of the U.S.;

- the impact of increased uncertainty created by such defenses upon retaliatory (second-strike) nuclear attack planning, as well as on Soviet first- strike attack planning;

- the extent to which strategic defense deployments would trigger countermeasure/counter-countermeasure responses; and

- the comparative effectiveness of other defense programs relative to SDI that create uncertainty in Soviet war planning and enhance deterrence.

6. The Zenith Star experiment should be reviewed within the next 12 months to ensure that costs of this program do not exceed the value of the information to be obtained.

7. A "Red Team" office should be established outside of SDIO with the funding necessary to conduct experiments and other research on possible Soviet countermeasures to Phase I deployment. This would provide a more informed basis for key SDI decisions and a useful foundation for U.S. options in responding to the potential Soviet breakout from the ABM Treaty that the Administration warns may be imminent. Particular attention should be paid to the issues of mid-course discrimination, faster burning boosters and buses, [ ].

8. SDIO should lead an interagency review of the feasibility of an Accidental Launch Protection System (ALPS) and its compatibility with Phase I. Special attention should be given to: the probability of accidental/unauthorized launches and the size and characteristics of possible attacks; the impact of SDI countermeasures on ALPS; possible ALPS architectures; the advantages and drawbacks of making some or all of the ALPS interceptors nuclear-armed; ALPS-required changes in the ABM Treaty, and consequences of a mutual U.S./Soviet ALPS deployment.

1. INTRODUCTION

For each of the past two years, Senators William Proxmire and Bennett Johnston have directed members of their staff to prepare an in-depth report on the Strategic Defense Initiative. Senator Dale Bumpers has joined them this year in commissioning a third report.

The first report was prompted by the claims of senior Administration officials that SDI had made tremendous strides and "incredible" breakthroughs in the previous two years. That report, entitled SDI: Progress and Challenges, was issued on March 17, 1986. It concluded that while progress had been made in the program, no tremendous breakthroughs had been achieved to warrant the Administration claims that comprehensive strategic defenses were feasible. Furthermore, the study detailed significant problems that strategic defenses faced, such as satellite survivability, discrimination of warheads from decoys, and space transportation and logistics.

Statements by Cabinet members late in 1986 and early 1987 urging commitment of this country to a so-called "near-term" deployment of strategic defenses prompted Senators Proxmire and Johnston to request an updated staff study to examine the progress SDI had made since the release of the first study and to assess the extent of any reorientation of the SDI program toward an early deployment. This second study, SDI: Progress and Challenges, Part II, dated March 19, 1987, concluded that despite the fact that no SDI weapons system was ready for deployment, the Strategic Defense Initiative Organization (SDIO) had reoriented its program to pursue vigorously a near-term deployment of ballistic missile defenses, possibly in the 1994-95 time frame.

That deployment would rely not on the lasers or beam weapons popularly associated with SDI, but rather on "kinetic kill" weapons to provide only a token overall defense with an effectiveness against Soviet ballistic missile warheads that the staff authors estimated at no more than 16%. In other words, about 4 out of every 5 Soviet warheads would penetrate the defense. The report revealed that Congress and the American people were being kept in the dark about this reorientation. SDIO was telling members of Congress and their staffs that no near-term architecture existed at the same time it was developing the reference architecture necessary for a near-term deployment.

After publication of the second report, SDIO's reorientation toward an early deployment became clear. On August 21, 1987, Defense

Secretary Casper Weinberger wrote in an article in the New York Times, "With adequate funding for the SDI program, we could confidently anticipate that phased deployment could begin as early as 1994 or 1995. In my view, no technical roadblocks stand in the way. The real roadblocks are presented by Congressional funding cuts."

Five years ago, on March 23, 1983, President Reagan first set forth his vision of a space-based defense, which he has said, would "set us free from the prison of nuclear weapons." With the approach of SDI's fifth anniversay, Senators Proxmire, Johnston, and Bumpers, all Members of the Senate Appropriations Committee, directed their staffs in January to prepare a third staff report on the progress of SDI to date and the challenges that lie ahead. This report is the result of that directive and primarily is based on information obtained in 1988.

SDI's fifth anniversary is an especially appropriate time to stand back and take stock, now that the Congress has appropriated over $13 billion for the program since its inception. Using the GNP deflator, this funding for SDI has been about the same as what the Manhattan Project required during the period from August, 1942, to December, 1946, in developing and producing the first nuclear weapons that hastened the end of World War II.

In preparing this report the authors interviewed or were briefed by more than 120 SDI managers, scientists, engineers, industry representatives and ballistic missile defense experts. We were briefed by Gen. Abrahamson, Director of SDIO, as well as by SDI's top program managers in charge of Directed Energy Weapons; Kinetic Energy Weapons; Sensors; SDI Systems; Survivability, Lethality, and Key Technologies; and Battle Management, Command, Control, and Communication .

We also visited the following facilities conducting SDI research:

* Los Alamos National Laboratory, Los Alamos, New Mexico. Los Alamos is conducting extensive research into various directed energy concepts, including neutral particle beam weapons or interactive discriminators, and the Radio Frequency (RF) Linac FEL.

* Sandia National Laboratory, Albuquerque, New Mexico. Sandia is conducting research into various directed energy concepts, space power systems, threat analysis, Soviet countermeasures, space survivability and systems concepts.

* Lawrence Livermore National Laboratory, Livermore, California. Livermore is conducting research into several directed energy weapons concepts, including the Induction Linac FEL and the x-ray laser.

* U.S. Air Force Space Division, Los Angeles, California. One of five divisions of the Air Force Space Command, the Space Division executes the services's research into SDI, particularly as it

relates to boost, post-boost and mid-course defenses. We were briefed on the space-based interceptor (SBI) program, the boost surveillance and tracking system (BSTS), and the space surveillance and tracking system (SSTS).

* Lockheed Missile and Space Corporation, Sunnyvale, California. We were briefed on BSTS, SSTS, the beam control subsystem of the ground based free electron laser (GBFEL TIE Program) and the exoatmospheric reentry vehicle interceptor subsystem (ERIS). We were also briefed in Washington, D.C., on the possible use of ERIS for an accidental launch protection system.

* Martin Marietta Corporation, Denver, Colorado. We were briefed on their work on the SBI, the National Test Bed, the Zenith Star space experiment, and the Rapid Re-targeting and Precision Pointing Laboratory.

* TRW, Los Angeles, California. We were briefed on the SSTS program, GBFEL-TIE, Mid-Infrared Advanced Chemical Laser (MIRACL), Alpha/Zenith Star and FEL technologies.

* Hughes Aircraft Company, El Segundo, California. Briefings included reviews of the BSTS, SSTS, GSTS, Airborne Optical Adjunct (AOA), HEDI, the Lightweight Exoatmospheric Projectile (LEAP) and Theater Missile Defense Architecture Study (TMDAS).

* Rockwell International, Los Angeles, California. We were given an SDI systems briefing including architecture, survivability, effectiveness and potential threats. In addition we received briefings on SBI, BSTS, and FEL.

In addition to the above visits we received briefings from ballistic missile defense experts from the Central Intelligence Agency, the Defense Intelligence Agency, the U.S. Navy, the U.S. Air Force, the Congressional Research Service, and the Stanford University Center for International Security and Arms Control. Finally, we also met with additional individuals and organizations with special expertise in this field, who wish to remain anonymous.

We would be remiss if we did not acknowledge the considerable efforts of the Strategic Defense Initiative Organization to accommodate our requests this year for information and briefings here in Washington and in the field. Their officials were always patient with our numerous questions and helpful beyond our expectations. We are grateful to Gen. James Abrahamson, Director of SDIO, for his willingness to facilitate our study of the SDI program. The contractors and national laboratories, as well, deserve our gratitude for their generosity with their time. Finally, we owe a special debt of gratitude to the legislative affairs liaison personnel at SDIO. While being steadfastly loyal to their mission, they earned a special

credibility with us.

As with the 1986 and 1987 studies, this year's report is not intended to be a comprehensive assessment of the SDI program. Rather, we have attempted to highlight key issues with respect to SDI that Congress may want to consider in the months to come.

1. AN OVERVIEW OF SDI POLICY AND PLANS FOR PHASE I

Policy

For several years after the President's nationally-televised SDI speech of March 23, 1983, the articulated goal of the SDI program was to render the United States safe from nuclear attack by making nuclear weapons "impotent and obsolete," to use the President's language. The basic concept often used to illustrate this was a multilayered set of systems, each of which would screen out a high percentage of attacking Soviet missiles and warheads.

One frequently cited example was a three-layer system, each layer eliminating 90% of the threat. Thus after passing through the first layer, 10% would remain, after the second, 1% and after the final layer, only 0.1% of the threat would be viable. Only 10 warheads of 10,000 launched would get through, with this described by some as being tantamount to being fully protected against the nuclear threat. As the magnitude of the SDI challenge has become better understood, this example quietly has been dropped.

Almost every government official below the President soon recognized the virtual impossibility of achieving this kind of "astrodome defense" and began subtly steering SDI away from this goal. Instead, the more realistic goal of using SDI to strengthen deterrence--the very doctrine of being able to inflict unacceptably high nuclear destruction on one's adversary that the President had denounced as immoral--began to be touted, at first quietly but then more and more openly.

On the same day in 1983 that President Reagan told the American people that strategic defenses could <u>replace</u> strategic deterrence, the Assistant for Directed Energy Weapons, Air Force Major General Donald Lamberson, told the Senate Armed Services Committee that the primary goal of strategic defenses (as well as offenses) was "deterrence of strategic attack." He said, "Our program is dedicated to determining whether directed energy weapons, deployed in concert with other strategic defense systems, can more nearly balance the offense/defense scale which has been dominated by the offense since the introduction of nuclear weapons." He further stated that directed energy weapons could "engage and defeat <u>limited</u> nuclear strikes" (emphasis added) in the boost phase. Instead of a leakproof defense, he argued that a constellation of directed energy weapons in space could destroy perhaps "50%" of the Soviet missiles in an all-out attack.

In the series of briefings we received from government officials and contractors, we were repeatedly told not only that the idea of a perfect or near perfect defense shield was not SDI's goal, but that it never had been. As one senior contractor official who formerly served in SDIO told us, "The idea of a leakproof defense shield is only in a few people's imagination. We have never supported that."

We recognize that Secretary of Defense Frank C. Carlucci has recently written an article denying that the President's vision has been abandoned. And certainly that is the publicly advertised goal of SDI. But it is clear from the structure of the program, the details of the system operational requirements and -- most importantly -- from the private words and plans of senior SDIO and contractor officials, that "rendering nuclear weapons impotent and obsolete" is not so much a goal as a slogan that has had little bearing on the program as it has evolved since 1983.

SDIO states that its goals for Phase I are:

- to strengthen deterrence by taking away the confidence that an attacker could achieve his objectives by launching first. Without defenses, it is argued, the Soviet Union could destroy almost all the targets it aimed at, including US ICBMs, because we would have no defenses.
- to provide some level of protection should deterrence fail, though probably not enough to prevent large scale devastation to the US.
- to provide some arms control incentives to the Soviets (though as we will discuss, this assertion is supported by arguments that are open to serious question).
- to lay the foundation for subsequent evolution of strategic defenses.

With SDI, a significant fraction of the targets supposedly would be spared, meaning that some ICBMs, communications sites, and command posts would survive to strike back against the Soviet Union. Since the Soviets would have no way of knowing in advance which targets would be protected and thus could not direct extra warheads to those targets, they would not be able to achieve their attack objectives. If the Soviets ever did attack, some level of protection would be provided, though not enough to prevent widespread damage to the US.

A vestige of the old near-perfect defense goal remains in the statement that "the purpose of the (Strategic Defense) initiative is to determine the feasibility of eliminating the threat posed by strategic nuclear missiles to the US and its allies," but that goal effectively

is ignored in the SDI program. When we asked SDI officials about this goal, they talked in terms of seeing what might be possible at a much later stage of the program. They did not appear to view it as a specific objective to be pursued seriously.

Program Overview

As the SDI Organization (SDIO) January 1988 presentation to Congress makes clear, the SDI program recognizes that technology advances will benefit the offense as well as the defense, and that various candidate SDI systems are in different stages of development. To take both factors into account, SDIO envisions that any initial SDI system deployed would constitute only the first phase of a more comprehensive system. Follow-on phases of this system involving more sophisticated components would be needed to respond to newer offensive technologies that would render the first phase ineffective.

The collection of SDI system components and how they interact with one another is often referred to as an "architecture." The persistent failure of SDIO to articulate a clear architecture in the past has been a continuing weak point in the program, since it is difficult to plan a system whose basic structure is not known. As one SDI official with substantial program management experience put it, "normally you would define an architecture first, then do the R&D on its elements. It is not typical to do both together, and it is a risky approach."

In recent months SDIO has proposed a specific architecture for the first phase of SDI deployment. This clearly has had a beneficial effect on program coherence, and it has helped Congress understand the full scope of the plan. Some SDI scientists were quite pleased by the involvement of the Defense Acquisition Board (DAB) and the application of the formalized defense acquisition process to SDI because it tends to prevent a "runaway decision" and puts the "hot breath" of the DAB behind the program managers.

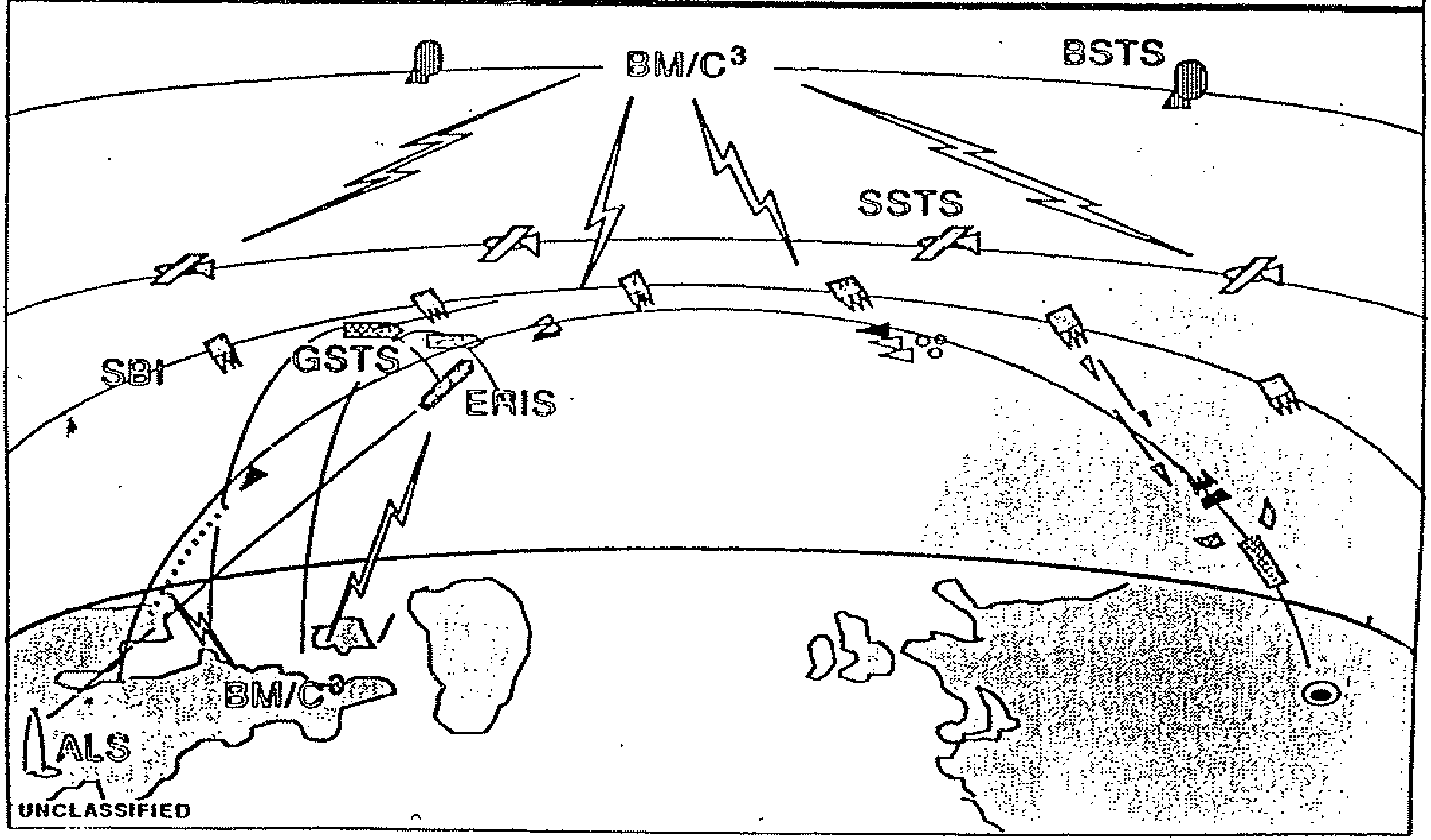
Below we review the components of this Phase I architecture and how they fit together.

Phase I Architecture

The first phase of SDI, which embodies the most near-term technology, would begin to be deployed no earlier than 1996 according to official documents, and more likely the late 1990's in view of programmatic, technical, and budgetary restraints, as will be discussed later. Phase I of SDI has seven major components, which are illustrated in Figure 1.

1. Boost Surveillance and Tracking System (BSTS). The BSTS system consists of [ ] satellites, depending on how robust a system

FIGURE 1. SDS PHASE I ELEMENTS (U)



is sought, in approximately geosynchronous or higher orbits. A [ ] satellite BSTS constellation was in the nominal Defense Advisory Board (DAB) architecture. Similar to, but more advanced than, our current DSP early warning satellites, BSTS would "sound the alarm" when Soviet missiles were launched, its infrared sensors detecting the hot exhaust plumes of Soviet missiles.

BSTS would also track these missiles for a short period, enabling it to make a preliminary estimate of the missiles' trajectories and impact areas. This information would then be passed on to other components of SDI about [ ] seconds after the Soviets launch their missiles. How precise this information is and how useful it would be to these other components is a matter of some dispute in the SDI community. While [ ] BSTS satellite can provide the information required by the Phase I system for a missile launch, [ ] is required to provide the information on a timely basis.

There is also some confusion within the community over the ability of BSTS to detect and track post-boost vehicles (PBVs), the "buses" which dispense the warheads, decoys, etc., that the missile boosts into space. This issue is significant because SBI achieves a significant proportion of its "kills" in the post-boost phase, despite its reputation as boost-phase killer.

If BSTS cannot track PBVs, SBI's ability to make these post-boost kills could be reduced appreciably. The Air Force, which manages the program, and some contractors stoutly maintain that BSTS will be able to track PBVs. Other contractors and scientists assert just as firmly that it could not, or that at most it could detect just the brightest events of the [ ], but even that is viewed as marginal.

SDIO has stated in its January 1988 "Report to Congress on Strategic Defense System Architecture" that [ ].

2. <u>Space-Based Interceptors (SBI).</u> Formerly known as space-based kinetic kill vehicles (SBKKV), SBIs are small, highly accurate rockets designed to crash into their targets. The SBIs move so fast that their impact alone is sufficient to destroy the target. Housed in groups of [ ] on each carrier satellite (the baseline design calls for [ ]) SBIs would have onboard infrared sensors that enable them to home in on the hot exhaust plumes of Soviet missiles. SBIs also would receive several in-flight target updates [ ].

Under current SDIO plans, the date for an "informed decision" on SBI has slipped to [ ]. SDIO has not provided official dates for full scale engineering development, initial deployment or

full operational capability of a Phase I system. But we believe an initial deployment could occur [ ] with full operational capability by [ ].

SBIs and their carrier satellites would be in orbits [ ], since they try to intercept Soviet missiles in their boost phase, when the missiles are still fairly close to the earth. At these altitudes, the carrier satellites would orbit the earth about [ ], so that at any given time only a fraction of the total number of SBIs would be within range to shoot down Soviet missiles. The term "absentee ratio" is used to describe the percentage of SBIs that are not within attack range of, or "absent" from, Soviet missiles during their boost phase.

The more quickly a missile can complete its boost phase, the lower the percentage of SBI carrier vehicles that would be in range to attack it, i.e., the higher the absentee ratio. Typical boost phases for current generation Soviet missiles last as long [ ] minutes. Against these missiles, the absentee ratio typically cited for SBI is about [ ]. Thus a Phase I system consisting of [ ] carrier vehicles, with [ ] SBIs would be within range of Soviet ICBMs when they are first launched. One contractor engineer cited a figure of [ ] CV's that would be within range of a Soviet launch.

Solid propellant missiles, like the SS-24 and SS-25 ICBMs that the Soviets recently have begun to deploy, [ ]. And in the 10 years before SBI could be deployed this boost phase duration likely will shrink still more. Thus the absentee ratio of SBI would be higher for the newer generation of missiles that SDI likely will confront a decade from now.

A fundamental problem facing SBI is that its capability for boost and post-boost intercept can be eroded seriously by Soviet countermeasures. As one SDI scientist has written, these "obvious countermeasures, which need not involve large incremental expenses (for the Soviets) if implemented in the normal course of deployment...would be difficult to counter with KEWs (kinetic energy weapons, i.e., SBI) alone and could erode KEW's effectiveness in the mid to long term." These countermeasures are discussed in chapter 6.

If SBI could be given reliable and accurate information on Soviet post-boost vehicles and reentry vehicles (RVs), SBI may have the capability of attacking PBVs while they are dispensing warheads during the post-boost period and especially RVs during the midcourse period. This would extend the usefulness of SBIs, though of course it is always preferable to destroy a missile during its boost phase when it still has its full load of warheads and is easier to track.

It is generally accepted that SBI's effectiveness will be at its highest when it is first deployed, and that this effectiveness will be

eroded as the Soviets respond to it. The debate on SBI centers on how effective it will be initially and how quickly this level of effectiveness will be eroded.

3. Space Surveillance and Tracking System (SSTS). SSTS would be a constellation of satellites that track the mixture of warheads, decoys, chaff, and debris that would make up the so-called "threat cloud" during the midcourse phase. This constellation would consist of [ ] satellites. Not only must SSTS track each of the components of the threat cloud accurately, but it must also be able to determine which are actual warheads and which are decoys or debris. Accordingly, the kinds and capabilities of sensors aboard SSTS are crucial to its performance.

Primary sensor candidates are passive infrared sensors that can "see" several different wavelengths of infrared radiation, particularly long wavelength infrared (LWIR) though visible light and radar sensors also are under consideration. LWIR sensors are especially important because warheads in space radiate in this regime. The rule is, the cooler the radiating body, the longer the wavelength and the fainter the radiation at any given distance. To first approximation, if an object is twice as hot as another, its radiation intensity is 16 times greater.

Rocket plumes are extremely hot, so their IR radiation generally is shorter wavelength and is very intense. Not only is a cold RV far more difficult to "see", but the temperature of the sensing optics can mask the signal from the RV. While [

].

Typically a warhead weighs much more than a decoy, and since in the cold of space the warhead does not cool off as quickly as a decoy, it would have a greater IR signature. SSTS would seek to detect this difference and discriminate between real RVs and decoys.

SSTS would transmit its information to the other major SDI Phase I components. ERIS, GSTS and SBI to a certain extent would be dependent on the SSTS data.

4. Ground-Based Space Tracking System (GSTS). GSTS is a ground-based sensor system designed to provide tracking information to SDI components that will come into play primarily during the late midcourse and to some extent the terminal reentry phase. This component has had several proposed versions in recent months, but the approach that has been adopted is a "pop-up" GSTS that would mount a sensor package on a ground-based rocket.

When warned by other sensors that an attack was under way, GSTS rockets would be launched, boosting the sensor package into a "lofted"

trajectory that would give it a few tens of minutes [ ] to track portions of the threat cloud. GSTS would track and discriminate objects in the threat cloud in the later midcourse phase from closer ranges than SSTS. This information would then be transmitted to the ground where it would be further analyzed and used to assign weapons, such as ERIS interceptor rockets, to targets.

A related part of GSTS would be a purely ground-based radar (GBR) which until recently was called the terminal imaging radar. In our briefings we were told that GBR's inclusion in Phase I was imminent but in a subsidiary role. GBR, which could be mobile and based on trucks or trains, would be able to observe the threat cloud, but not until even later in the [ ].

GBR would track portions of the threat cloud cued to it from sensors further upstream and pass the information on to the battle management part of Phase I for weapons allocation and targeting. Its mobility would provide greater survivability than a fixed-based radar. Several scientists pointed out that GBR would be vulnerable to "blackout" from nuclear explosions.

The very existence of the GSTS component in the Phase I architecture is tacit recognition of some important technical problems faced by Phase I. SDIO's statement that GSTS "would provide the capability to examine high-threat corridors in detail and to be placed in areas where very high resolution may be warranted" is a back-handed way of saying that there are serious concerns about whether SSTS will be fully capable of performing these tasks. Dense threat clouds could pose important resolution problems for SSTS. Left unsaid is the fact that the ground-based GSTS partly is an attempt to make up for the serious survivability problems of the space-based SSTS.

Despite several years of study, SSTS requirements still are fluid. For example, one SDI official told us that "SSTS is immature enough in terms of development" that SDIO is looking at the possibility of having an on-board [ ] The SSTS flight demonstration experiment has been delayed [ ] due to budgetary pressures.

5. <u>Exoatmospheric Reentry Vehicle Interceptor System (ERIS)</u>. ERIS is a ground-based two-stage missile designed to intercept Soviet RVs during the late midcourse phase using data provided to it by SSTS and GSTS. The ERIS interceptor would be launched toward a particular point in space where the RV would be expected to arrive. [ ]

It should be noted that such impact could lead to the detonation of the nuclear warhead inside the RV since the Soviets can equip their nuclear warheads with a so-called "salvage fuzing" mechanism. This would trigger the warhead in microseconds if it experiences a sudden deceleration such as happens if the RV hits the ground without previously exploding or if it collides with an ERIS missile.

Such explosions could significantly interfere with the ability of other SDI sensor systems to function. It is important to emphasize that for ERIS to function, it must receive reliable information from other SDI sensors upstream, particularly SSTS. If warheads are not discriminated from decoys, chaff, and debris in the threat cloud, ERIS could easily be overwhelmed by the sheer numbers of objects in the cloud.

6. <u>Battle Management/Command-Control-Communications (BM/C3)</u>. Often the most underappreciated component of any ballistic missile defense system, the BM/C3 system for SDI plays the crucial role of coordinating and managing the many elements of an overall SDI system. Consisting of an awesome array of sophisticated computer systems and associated software, plus high data transmission rate communications systems and a host of related equipment, the BM/C3 is the brains behind SDI. It is one of the least well-defined of SDI's components. As the Defense Science Board's <u>Strategic Defense Milestone Panel</u> noted, "the design of BM/C3 components is in a very early stage, reflecting the sketchiness of the system design as a whole."

Key among the BM/C3 tasks are the determination of missile, PBV, and RV trajectories, the allocation decisions necessary to determine which weapons should be fired at missile and ASAT targets and the intercept points they should be fired at, and maintaining ground contact, both to keep military and civilian leadership informed and to obtain direction from earth-based authorities. Vast amounts of information will have to be transmitted among all the space-based components on a constant basis under the current BM/C3 Phase I concept, as each CV will need to know the location and status of every other CV.

This requirement for extensive communications among the constellations of 300+ CVs arises because each CV would have to determine on its own which targets it should fire at, based on the available sensor information, rather than have the decisions made in a single location. Each CV must know the "health and status" of every other CV, in addition to other targeting data. This would avoid a situation where CVs which have exhausted their magazine of weapons or have been destroyed by Soviet counterfire take a target away from a functioning CV.

Communications among SBI space-based platforms is essential. Two modes of high-speed communications are under investigation: [ ] RF

links, and laser communication links. The [ ] links are more mature, but one contractor reports that just two Soviet satellites could jam all SDI communications links for five minutes, rendering the Phase I system completely worthless. Laser communication would be more secure, but designing and building reliable agile beam steering optics to direct narrow laser beams between hundreds of satellites would be a daunting task.

BM/C3 probably is the least well-defined of all Phase I components and it continues in a state of flux. Until fairly recently, SDIO had been planning on putting the bulk of the BM/C3 function in a dedicated set of [ ] satellites that would have orbited at altitudes of [ ] miles. Within the last 12 months SDIO has decided against this concept and in favor of putting the BM/C3 tasks on the existing weapons and sensor platforms, including BSTS, SSTS, and the SBI carrier vehicles.

The BM/C3 concept contained in the architecture briefed to the DAB in September assumed that the computation of missile/PBV/RV flight trajectories as well as the weapons engagement and allocation decisions would be performed on the SBI carrier vehicles. Yet six months later this may already be changing -- there is a strong move afoot to shift the flight trajectory calculation from [ ].

Putting this calculation on [ ] would be less expensive. This is one more example that fundamental system parameters and tasks remain undefined and fluid. This is also seen in the fact that the BM/C3 concept for the key SSTS satellites has not been developed. "We haven't taken a hard look at battle management in SSTS yet," reported one official in the program.

7. Advanced Launch System (ALS). ALS is an advanced launch vehicle that would be used to boost the bulk of the space-based Phase I components into orbit. To quote SDIO, "while current launch systems can begin SDS Phase I deployment, an ALS will be required for a cost-efficient, timely and complete SDS Phase I deployment" (emphasis added). The goal of ALS is to provide a launch system capable of putting payloads into low earth orbit for $300-$400 per pound, about one-tenth the current cost of $3,000-$5,000 per pound. The earliest likely date when ALS would become available is [ ], though there are a number of indications that this could slip [ ].

Phase I Operational Requirements

The Joint Chiefs of Staff have issued operational requirements for the Phase I architecture. These requirements are stated by the [ ], which was used by SDIO to brief the DAB

on Phase I. The requirements are:

[
]

-- "at least [ ] of all the estimated [ ] of the estimated [ ] RVs launched in the first wave of a heavy Soviet attack should be destroyed."

[ ]

According to SDIO's official threat document [
] (30 September, 1987), the first wave of a Soviet attack is projected to contain [ ] warheads. SDIO assumes this first wave contains [ ] boosters and [ ] warheads. The second wave is estimated by DIA to contain [ ] warheads. The JCS operational requirements do not task Phase I to meet any performance goal against [ ], and none is enumerated in [ ].

The [ ] wording of the JCS requirement is ambiguous. The Phase I task, to quote [ ], is to destroy "at least [ ] of <u>all</u> the estimated [ ] of the estimated [ ] RVs launched in the first wave [emphasis added]." The use of the word "all" implies that [ ] is the <u>overall</u> effectiveness requirement against the first wave of the attack, not just against the [ ] RVs.

However, as General Herres, Vice Chairman of the Joint Chiefs, explained to the Senate Armed Services Committee in March, the JCS want Phase I to destroy [
]. This interpretation also appears to be the one followed by most SDI contractors, and it is the one we shall use here. Under this interpretation, the JCS requirement becomes:

[ ]

[ ]

[ ]

That is, slightly more than [ ] of all RVs in the first wave are killed, not [ ] as [ ] implied.

We note that on another point, in explaining the [ ] part of the JCS requirements to the Armed Services Committee, General Herres stated that "we would assume that all of it [ ] would be [used in the first wave of the attack]. I think that this is a fair

assumption." None of the officials with whom we spoke or any SDIO documents we have seen follow this interpretation, so we will not.

A requirement to destroy [ ] of the attacking [ ] warheads easily could be met by ratifying a START treaty. While negotiations are not complete, the Soviets have agreed to cut their [ ] deployments in half. Coupled with other reductions the Soviets have accepted, a START treaty would reduce the Soviets to 4900 ballistic missile warheads. This is a [ ] reduction from the total [ ] projected threat for 1996, not just a reduction in the first wave of attacking RVs.

Charts produced by a number of contractors make clear that most of the [ ] RVs killed by Phase I are [ ] RVs. [

]. The [ ] will give the Soviets appreciable counter-military potential by the mid-1990s.

A natural question to ask is, if Phase I would destroy [ ] RVs, how many would still get through? Of course since Phase I would have no effect on bombers and cruise missiles, their [ ] warheads would survive. But for missile RVs alone, the answer depends on the estimate size of the Soviet missile threat. (see Table 4 in Chapter 10).

Based on the information in Table 1, estimates of Phase I leakage are shown below:

Table 1

Estimate	Warhead Level- JCS Rq'mt = Potential Leakers	Phase I Kills
[		

DELETED

]

This Table shows that a Phase I meeting JCS operational requirements would destroy [ ] of the ballistic missile warheads in the projected [ ] Soviet inventory. If the [ ] can be modified to reduce its booster and bus burn times this figure would probably drop to [ ] or less.

<u>Remarkably, START would be [ ] more effective than Phase I in reducing the Soviet offensive missile threat.</u>

Another facet of this issue is what Phase I would protect. About two-thirds of the RVs destroyed by Phase I under the JCS requirements are [ ] RVs. For a [ ] RV threat level, the JCS require that only [ ].

The [ ] are the only Soviet missiles estimated to be fully hard target capable by [ ]. The [ ] plays a predominant role in Intelligence Community assessments of the Soviet ability to attack U.S. ICBM silos. Thus, the JCS requirement to destroy [ ] of the Soviets' [ ] RVs and the derived actual requirement to destroy about [ ] Soviet RVs <u>is a de facto requirement to defend hardened military targets--ICBM silos and launch control facilities</u> -- and to leave essentially unprotected the rest of the US population, economic infrastructure, and soft military targets. SDIO may well argue that Phase I would provide some population protection in a nuclear war. The reality is that under a "thin" Phase I deployment, population protection would be almost nil.

The fact is, Phase I concentrates on the lumbering [ ] threat because that is about the only Soviet missile in the mid-to-late 1990's against which Phase I can be effective. Seen in this light, the

minuscule JCS performance requirement for [ ] missiles is a concession to reality.

The unavoidable conclusion is that Phase I would provide far less defense for people than for ICBMs.

3. SDI RESEARCH HIGHLIGHTS

In our earlier two reports we recounted the Administration's claims of "amazing breakthroughs", "incredible" progress, and "dramatic results" with SDI. This year on March 14, 1988, President Reagan reminisced about the birth of SDI five years ago:

> "If anything, we overestimated the technological challenge back then. The technologies of our Strategic Defense Initiative have progressed more rapidly than many of us ever dreamed possible."

Based on our many briefings and interviews with SDI and contractor scientists, we agree that there has been impressive progress in some areas of SDI research. The massive infusion of funding should yield impressive results. But it also seems clear in the fifth year of the program that the technological challenges of building a comprehensive ballistic missile defense of very high effectiveness have proven more difficult than earlier imagined.

It is useful to recall that on March 23, 1983, the same day that President Reagan delivered his now-famous SDI speech, the Air Force told the Senate Armed Services Committee that the DOE Space Laser Plan could conduct the research to reach a demonstration and validation decision in FY 1988 on space based lasers for a <u>total</u> of $900 million over fiscal years 1982 - 1988. SDI, with far greater funding, is not scheduled to reach a demonstration and validation decision on space-based lasers until several years later. The challenges of using directed energy weapons for ballistic missile defense appear to have been more daunting than was anticipated in 1983.

<u>Delta 181</u>

Much has been made of the Delta 181 experiment that SDIO conducted on February 8-9, 1988. On March 14, 1988, President Reagan said:

> "But some of the difficulties they said were insurmountable have already been surmounted -- much more rapidly and effectively than anticipated. For example, our Delta 180 and -- most recently 181 tests, demonstrating among other things our ability to track fast-moving targets in space and distinguish between dummy warheads from the real thing, showed a technical ability that

some scientists, concerned and otherwise, had said could not be achieved so quickly. "

As was the case last year, the centerpiece of SDI test activity was the launch of a Delta rocket into space to collect information on how objects appear in space. The objective of the Delta 181 experiment was to characterize in a realistic environment the kinds of targets SDI might encounter from a responsive Soviet threat in the mid-course. This entailed studying not only how the objects themselves appeared, but also their rocket plumes, spacecraft glow and gas releases, and the space background against which they were seen.

Although the actual collection of data in the experiment took only about 10 hours, the Delta 181 payload package ejected 14 "test objects" into space (four of which fired solid rocket motors for plume characterization) and tracked them with infra-red, ultraviolet, laser and radar systems. In addition the experiment collected data on space backgrounds against which SDI sensors would have to look for their targets. Ground-based sensors and aircraft-based sensors both were employed to collect data. To create additional realism, a Strypi-11 rocket was fired from Kauai, Hawaii, for the Delta 181 sensors to study from space. Apparently the Strypi fired 30 seconds late, causing Delta-181 to miss it, [
].

Unquestionably, this $250 million experiment was a complex undertaking. Large amounts of data were generated that are still being studied. SDIO officials said that the experiment succeeded in characterizing the test objects, their spacecraft glow and gas releases, and the space backgrounds. The characterization of rocket plumes in space was "successful with anomalies". [

].

The Delta 181 experiment indicates the concern SDIO has about the possibility of the Soviets responding to Phase I with not just decoys, but sophisticated decoys. The test objects included replicas of reentry vehicles, including a [ ] decoy, which were observed at distances ranging from [ ]. While SDIO officials were enthusiastic about their ability using the preliminary data to discriminate the real re-entry vehicles from the decoys in the Delta 181 experiment, they say the data requires much further analysis. The SDIO officials with whom we spoke are certainly <u>not</u> suggesting that the mid-course discrimination problem is solved.

<u>Directed Energy Weapons</u>

The following highlights progress of research in directed energy technologies in the last year:

1) Free Electron Laser (FEL) - - For the past two years, the free electron laser technology concept was SDIO's candidate of choice for a high power laser weapon. In conventional lasers the electrons bound up in the atoms of a material are excited to higher energy states. The electrons then give off coherent laser light as they move to a lower energy state. In an FEL, a beam of pure electrons, free from any atomic structure, is accelerated to nearly the speed of light. The kinetic energy of these electrons is converted to coherent laser light when the electron beam is passed through a magnetic "wiggler".

A ground-based FEL would attack a target by reflecting its beam off special mirrors placed in orbit. With few space-based assets, the FEL seemed to offer greater survivability than conventional space-based chemical lasers. The FEL has other potential advantages over conventional lasers in terms of wavelength tuning, high power capability, optical quality, and high efficiency.

Progress on the free electron laser continues to be quite good. Everyone with whom we spoke agreed that the FEL was meeting or exceeding its technical milestones. There are still two competing types of FEL technologies under consideration, the Radio Frequency (RF) linac free electron laser being developed by Boeing Co. and Los Alamos National Laboratory, and the induction linac FEL being developed by Lawrence Livermore Laboratory. Basically, the two concepts differ in the type of accelerator used. The RF linac appears to have potential as a space-based as well as a ground-based weapon, unlike the induction linac which is probably too heavy for basing in space. No clear winner has emerged, although in November SDIO thought a decision would be made by April, 1988. The program director said it is still a "horserace". He added, "I can't weed out anything now."

Both types of FEL lasers have now achieved lasing. Once a choice is made between the two, a low power test laser will be built at White Sands Missile Range for the Ground-Based Free Electron Laser Technology Integration Experiment (GBFELTIE). Six months ago the program schedule called for the FEL to come on line in late 1992, with the TIE experiment occurring in 1993. The program schedule now calls for a request for proposal to be issued in late 1988 with a contract award in June, 1989, and with the test system at White Sands coming on line by June 1994. However, few seem to think this schedule will hold.

Using that device SDIO will determine in an "uplink" experiment if a low-power beam can be sent from the ground to a beacon in space and be adjusted to compensate for disturbances in the atmosphere so as to maintain good laser beam quality. A beam control system is required that can determine how the atmosphere is changing (it changes about 1,000 times per second). Then using [ ] mirrors controlled by

actuators, the beam sent from the ground will arrive in space as a coherent high quality beam.

As for the space-based FEL effort the goal now is to conduct an experiment in space in FY 1994 - 1995. The decision to proceed to full scale engineering development will not be made until after this space experiment.

Despite good technical progress, there was obvious despair among the scientists working on both types of FEL because it has been displaced by the chemical laser as the primary laser candidate for SDI. SDIO originally selected the FEL concept over the chemical laser for the FEL's numerous technical advantages. SDIO is now in effect reversing the decision because the chemical laser offers one crucial advantage -- it is more mature, albeit less capable, and so can be deployed earlier to shore up Phase I. One SDI scientist put it, "The goals have receded under the pressure of near-term deployment."

In fact when we asked the DEW program manager if there had been some substantial breakthrough on chemical lasers, he responded, "There has not been any big epiphany. We haven't invented anything new." However, he was not willing to concede that the change in priority for the chemical laser was due to the push for Phase I deployment.

The reversal of priorities shows in the budget allocations. The problem is not just a lack of funds for SDI, but the priorities in the use of those funds. In briefings to Congressional staff in November, 1987, FEL program officials said they needed $200 million in FY 1988 to stay on schedule and they thought that if SDI was funded at $3.9 billion, then SDIO would allocate $200 million to the FEL program. Although SDIO did receive $3.9 billion, FEL was allocated <u>only</u> $155.5 million, a cut of 27% from their request. This was a nominal cut of 16% from the actual FY 1987 funding of the program. In stark contrast, the space based chemical laser received $108.5 million or 25% <u>more</u> than their FY 1987 budget request.

The situation for FY 1989 was even more dramatic. Last year the projected FY 1989 budget request for the FEL program was $250 million while that for the chemical laser program was $100 million. The actual FEL budget request for FY 1989 is down to $229 million for FEL, while the request for chemical lasers shot up to $261 million. Program budget projections show that funding requests for the space-based chemical laser will substantially exceed that for the FEL program for every year through FY 1994. The funding requested for FY 1989 would delay a Milestone I technical feasibility decision for FEL until 1993-1994, according to SDIO. Clearly, the chemical laser is now pre-eminent.

FEL funding cutbacks will not just create schedule slippage. One scientist expressed concern that the program will become "subcritical"

because the capability of the White Sands device is being reduced due to funding cutbacks. Some scientists worry that the result will be an experiment that yields less than useful information.

2) Neutral Particle Beam Research -- The shift in funding priorities within the Directed Energy Weapons program toward the chemical laser has also affected the neutral particle beam research program, despite what appears to be excellent technical progress. Neutral particle beams are produced by accelerating negative hydrogen ions to high velocities, directing them toward a target and stripping off the extra electrons, leaving the neutral hydrogen atom to proceed toward the target at nearly the speed of light. Being neutrally charged, the beam is undeflected by magnetic fields in space.

SDIO believes a space-based neutral particle beam accelerator would make an excellent interactive discriminator to distinguish light decoys from real warheads in the mid-course. When struck by a neutral particle beam an object will emit neutrons and gamma rays in proportion to the mass of the object. By measuring the strength of this secondary radiation, one can measure the mass of the object. Last year's report details the difficulties of building and powering a large neutral particle beam accelerator in space.

The neutral particle beam once was not thought to be particularly attractive as a weapon because it is difficult to confirm if the target is "killed" or just missed. The neutral particles can penetrate the surface of the target, "frying" the electronics inside, but leave no visible sign of destruction. The potential of the neutral particle beam as a weapon is now being reevaluated because of recent developments.

SDI program personnel say there is no doubt they can build a neutral particle beam accelerator and that the beam can be controlled. Questions do remain about how to power an NPB accelerator in space. Scientists at Los Alamos described what they called a "breakthrough" in their ability to reduce the weight of the radio frequency equipment required for the accelerator. They have well exceeded their weight goal for this equipment for flying an experimental NPB in the Space Shuttle.

The SDI scientists also described a "breakthrough" in the magnetic control of the beam. To control beam divergence it is necessary to expand the particle beam. They have made significant progress in this regard.

Stripping the electrons off the hydrogen ions as the beam leaves the NPB device was thought to be a difficult task. They have demonstrated that simply firing the beam through an aluminum foil will accomplish that step despite a very high heat flux. These scientists think they have the technology in hand to build a prototype NPB device.

A remaining critical question for NPB research is whether an operational system could distinguish neutrons generated in mid-course discrimination from neutrons naturally present. In August, 1988, the LACE experiment will carry a neutron detector to measure the earth's natural neutron radiation to help answer this important question.

Finally, NPB research will be advanced significantly by the Ground Test Accelerator, construction of which began last August. Once testing begins in FY 1990, this accelerator will be capable, lab scientists say, of addressing every issue a full-scale engineering development (FSED) board would have to resolve in approving construction of a prototype, space-based NPB device.

Despite the fact that NPB research met its technical milestones, its FY 1989 budget request was slashed to an amount less than its actual funding level for FY 1987. SDIO says that the FY 1988 and FY 1989 50% program budget cuts result in a program slippage of two years. No credible milestone decision on feasibility can be expected before FY 1994, even if the budget request is enacted. The Neutral Particle Beam Integrated Space Experiment was cancelled, although the Beam Experiment Aboard Rocket (BEAR) is being accelerated to give preliminary data concerning space operability issues in an FY 1989 launch.

A second promising directed energy technology, the NPB, is playing second fiddle to the space-based chemical laser. SDIO hopes the chemical laser will prove to be a good interactive discriminator even if it does not have the power to be an effective weapon against a responsive Soviet threat.

3) Nuclear Directed Energy Weapons - - SDIO and the Department of Energy continue a relatively small program of study into various nuclear directed energy concepts. The extraordinary power, small size and weight of a nuclear device make it an obvious subject of investigation as the source of energy for directed energy weapons.

In previous reports we have described progress on the x-ray pumped laser. We now know that the x-ray laser concept works because x-ray laser action has been achieved through excitation by a nuclear explosive. According to one Livermore scientist, "The issue is whether or not it is a weapon." He estimated that about $1 billion will be required in total to determine if a weapon is feasible. They are about 20% into the program and it is being funded at about $100 million per year.

There has been delay in the x-ray laser program for mundane as well as budgetary reasons. At one point, the cooks at the laboratory dining facilities went on strike, and the technicians involved in the x-ray laser program would not cross the picket line.

The x-ray laser is the ultimate SDI weapon. As one scientist put it, "It's the lightest weight, biggest guy in the sky." Protecting against this laser is prohibitively expensive because the x-rays penetrate all but the heaviest of shields. Proliferation [ ] is the only logical countermeasure.

This laser poses a fundamental dilemma for SDI: it is also the ultimate anti-SDI weapon. It can destroy satellites even better than it can destroy missiles. A Livermore scientist said that an x-ray laser that is an effective anti-satellite weapon requires [ ] less brightness than if it were used against current Soviet missiles. An anti-satellite x-ray laser is [ ] less bright than that needed to be effective against Soviet fast-burn boosters.

The obvious question is, will the Soviets develop the x-ray laser? Scientists say little is known about the Soviet effort in this area. [

].

4) Chemical Lasers -- Early in the search for high power lasers, scientists investigated a chemical laser using hydrogen (or deuterium) and fluorine as the energy source. A laser using these two elements is in essence a very high performance rocket engine. One problem is that fluorine is extremely corrosive. In this laser, hydrogen and fluorine are pumped into a combustion chamber, and the high power laser beam is extracted from the violent reaction of these chemicals.

There are several difficulties with the HF laser. First, a space-based HF laser would have to carry its fuel with it into orbit. Not being very efficient in the production of laser light, each laser weapon would require many tons of fuel. Second, the HF laser has a relatively long wavelength and so large optics (mirrors) are required to obtain high brightness in the laser beam. Finally, because it is difficult to achieve high brightness with the HF laser, the Soviets could adopt countermeasures such as hardening their boosters to protect them from the laser beam.

HF lasers have been exhaustively studied. As one scientist said, "Chemical lasers have died several times." In 1984 the "Fletcher" study, specifically recommended against deployment of the HF laser in the 1998 - 2000 time period, citing potential Soviet countermeasures. SDIO has recently reversed the priorities in the DEW program and is pursuing the technology for that identical chemical laser in about that time period to provide an early back-up to the Phase I deployment.

Why is the chemical laser getting another chance? As mentioned earlier, it is not because the chemical laser has enjoyed a

technological breakthrough. "There has not been any big epiphany," we were told by SDIO's program manager -- "We haven't invented anything new." Rather, because the chemical laser is relatively mature technology it can be deployed earlier than any other directed energy device to help shore up Phase I. One contractor working on a competing technology told us the interest in the chemical laser occurred because of "excitement over Phase I deployment ... DEW needed an active role."

What about the low brightness of the chemical laser? The answer is that SDIO is more interested in the chemical laser as a discriminator than as a weapon and therefore a lower brightness may be acceptable. The brightness proposed for a prototype chemical laser is exactly that described in the Fletcher report as being "not worthy of early deployment".

The SDIO program manager in charge of lethality research also confirmed that the brightness level ascribed to a deployed chemical laser would make it a discriminator, not a weapon. SDIO hopes to place in orbit the Zenith Star version of the chemical laser as an experiment prior to building a prototype. Referring to Zenith Star, one contractor said, "At best I call it a 'stunner', it's not a weapon." Then he added, "It's an okay experiment, but it doesn't lead anywhere."

While usually thought of as a Phase II component, the space-based chemical laser (SBCL) is being seriously considered for inclusion in the Phase I timeframe, as described earlier. Accordingly, it is important to review the technical challenges confronting the SBCL.

Without a doubt the major technological hurdle is survivability. By their very nature, SBCLs would be large, extremely high-value targets. "They'll be the aircraft carriers of space," as even one SDI proponent put it. And not even the Navy claims that aircraft carriers can survive against a determined nuclear assault team. A sure sign of the vulnerability of SBCLs is the fact that preliminary designs for them already allocate [ ] of their weight to protection and defense in the form of:

-- Shielding
-- [ ]
-- [ ]

Scientists working on the project admitted that an SBCL platform would be very vulnerable [ ].

SBCLs face other important technical problems, including enabling the optics to point at the many individual targets it would confront and destroy them one at a time quickly and accurately enough. Achieving the needed power levels and developing the needed adaptive

optics remain important problems, although useful progress in both areas has been made in the last couple of years.

5. Other Far-Term SDI Technologies

There are several other promising SDI technologies under investigation at the national laboratories. Some of the nuclear-driven concepts cannot be discussed under the classification level of this document.

The Fission Activated Light Concept (FALCON) program being conducted at Sandia is a space-based laser pumped by a nuclear reactor [ ]. Unlike other DEW programs, here the scientists involved were pleased with the funding SDIO provided them and they expected the trend to continue. Technical progress has been good, they "have made every milestone so far", we were told. Lasing was demonstrated in 1987, using a long, as opposed to a short, pulse, although the best lasant material has yet to be selected. The long pulse is known to be more effective in penetrating into the atmosphere, which may enable FALCON to reach the fast-burn booster. A go/no-go decision on FALCON is expected in late FY 1989. Deployment would involve large platforms in space weighing 7 - 40 tons each, depending on how short the desired retarget time is. Armoring the platform would add more even more weight.

Another far-term research program at Sandia is DELPHI, (for Discriminating Electrons with Laser Photon Ionization). In this concept a pop-up rocket would carry an electron beam accelerator into space where the device would ionize a channel in the outer fringe of the atmosphere and fire a beam of electrons through this channel toward a target. DELPHI was originally favored, not as a weapon, but as an interactive discriminator. It was known as the "AT&T equivalent" because it can "reach out and touch someone." However, in 1987 SDI scientists discovered that DELPHI may have potential as a weapon. They are now examining potential countermeasures to see if DELPHI can be easily foiled. Recent experiments have discounted the importance of certain suspected theoretical flaws in DELPHI. A rocket-borne space flight is scheduled for FY 1989 to verify space operability.

The reconnection gun is a research concept that may have even better potential for conventional weapons than for SDI applications. This device is an electromagnetic cannon that operates on a principle of creating, breaking, and reconnecting magnetic field lines to accelerate a projectile to very high speeds. The theory is now understood and experiments have achieved unprecedented projectile velocities.

Finally, we note a disturbing development in funding for the Support Programs for Directed Energy Weapons. This project funds

advanced research in fundamental science and engineering for ballistic missile defense. Nearly 100 contractors receive small contract awards ($50 - $500 thousand) to explore the forefront of technologies for DEW for ballistic missile defense. The Administration's allocation of funding for FY 1988 and their FY 1989 budget proposal results in a 66% reduction in the funding levels they had earlier planned for the FY 88-89 program in this area. The result "fundamentally limits the scope of the activities in this area," acknowledges SDIO. We question whether Congress would want this type of fundamental research on DEW to be what is sacrificed in the budget process.

4. STATUS OF THE EARLY DEPLOYMENT OPTION

Perhaps the biggest changes in the SDI program in the last twelve months stemmed from the Administration's earlier policy decision to seek a deployment capability beginning in the mid-1990's, about half a decade earlier than had been previously described. In last year's report one of our principal findings was that "the Strategic Defense Initiative Organization (SDIO) is reorienting its program to pursue vigorously a near-term deployment of ballistic missile defenses, possibly in the 1994-95 time frame." We reached this finding after discovering numerous indications of a major shift in the research program [ ] that was developing a reference architecture for an early SDI deployment.

At the same time, SDIO officials were telling Congressional staff that no such near-term architecture existed. Many staff were querying SDI about the subject because Secretary Weinberger had said in a speech on January 22, 1987, "We are now seeing opportunities for earlier deployment of the first phase of strategic defense than we previously thought possible ... our bags are packed."

When our report was released in April, Gen. Abrahamson, SDIO Director, vigorously denied our central finding about a reorientation toward an early SDI deployment. In separate letters to Senators Johnston and Proxmire dated April 8, 1987, he included the following SDIO comments on our staff report:

> There is a consistent theme in nearly all the findings: that SDIO is reorienting its program to vigorously pursue a near-term deployment. The fact is there has been no change in the SDI research goal. The objective is to explore a broad range of strategic defense options, extending from the most mature technology to most advanced technology.
>
> Based upon the progress to date, we remain convinced that the basic goal of the SDI is achievable. In fact, it may be reached much sooner than we had expected. This progress has enabled us to begin now to examine concrete working hypotheses about the defensive options that may be available in the early to mid-1990s. However, the SDI has not progressed to the point where discussion about an imminent "early deployment" would be appropriate."

Elsewhere, SDIO's objections to our use of the term "early deployment" were based on other grounds. In answers provided for the record to questions posed as a part of a hearing before the Defense Appropriations Subcommittee on March 19, 1987, Gen. Abrahamson said, "... it must be emphasized that the SDIO is pursuing a phased or incremental, deployment of a defense capability, as opposed to any sort of "early deployment, as mentioned in the question." In that same hearing he announced that with sufficient funding and support the initial phase of the SDI system could be in place in the early-to-mid 1990s.

The Reagan Administration's first comprehensive assessment of SDI technologies, was conducted by a panel of over 50 distinguished scientists, and chaired by Dr. James C. Fletcher. Their seven volume, classified Report on the Study on Eliminating the Threat Posed by Nuclear Ballistic Missiles, was also entitled, Technology Plan for The Strategic Defense Initiative, but is commonly known as the "Fletcher Report". Issued in February of 1984, the report included what was described as an "early deployment option" which would be part of a "phased deployment process". This option was described in an unclassified paragraph as,

> "An early deployment plan would provide for deploying elements of a BMD [ballistic missile defense] system as soon as technically feasible, assuming consistency with appropriate national policy, while continuing vigorous support of technology for the comprehensive system."

The architecture described in this early deployment option is almost identical to the Phase I architecture.

SDIO continues to argue that they are not pursuing an "early deployment". Rather, they stated they are pursuing merely a "phased" deployment. In our view they were one in the same last year, but this year Phase I has slipped in schedule to where it will not be "early". The existence of an "early deployment" effort is not a trivial issue of semantics because the Congress has enacted several prohibitions and conditions on SDI with respect to "early deployment".

In his March 14, 1988, speech, President Reagan acknowledged that the SDI program has been set back "one to two years". He blamed the delay on Congressional budget cuts. Based on our briefings and interviews, we conclude that SDIO cannot achieve the objective announced last year of supporting a Phase I deployment by the mid-1990s, which we have referred to as an "early" deployment. That effort has stalled because of uncertainties over the budget, launch capacity, and technical progress. SDI cannot, we conclude, deploy even this "thin" Phase I system before 1998 at the earliest. Full operational

capability would come after the turn of the century.

To understand how far SDI has been set back it is essential to understand how the goals of the program have shifted. Under President Reagan's vision SDI was to conduct the research to find the technologies to make nuclear weapons "impotent and obsolete". The Fletcher Panel's report established a schedule and technology roadmap which quickly evolved into a generalized goal -- a feasibility decision on SDI technologies, both exotic and conventional technologies, by the early 1990s. This decision generally was equated with a full-scale development decision on comprehensive ballistic missile defenses. Deployment would not come until after the year 2000. However, the Fletcher report did describe a possible "early deployment-oriented option" nearly identical to Phase I, that could be deployed earlier than the year 2000 as part of a "phased deployment".

The September, 1987 Milestone I decision on the Phase I architecture confirmed that only research on conventional kinetic kill weapons technologies -- SBI and ERIS -- could hope to meet a Milestone II decision (system development) in the early 1990s. The development decision on DEW technologies would come much later. In other words, the goal of completing the research by the early 1990s to determine if comprehensive ballistic missile defenses were feasible has evolved into making a decision by the early 1990s as to whether a "thin" ballistic missile system embodied in Phase I is feasible. As a result, the scope of the full-scale engineering development decision in the early 1990s has greatly narrowed.

This year we have seen repeated signs that the Phase I schedule is increasingly uncertain. For example, while Gen. Abrahamson told Congress this year that Phase I deployment could begin in 1996 or 1997, SDIO officials conceded that this might only mean the deployment of a single BSTS satellite. In a briefing to Congressional staff, when asked, SDIO officials declined to give any date for the initial operating capability (IOC) or the full operating capability (FOC) of the Phase I system.

They explained that the Joint Chiefs of Staff are studying the question of how much of Phase I must be in place to be considered militarily useful, the benchmark for determining an IOC date. The SDIO officials said we might not know what the IOC or FOC for Phase I is until the full scale development decision is made. Offering a date now would only be "guessing". Gen. Abrahamson declined to offer any IOC or FOC dates for Phase I during a hearing on March 31, 1988, until the questioner rephrased his question to include the assumption of unlimited funding.

In one briefing a contractor official said it directly, "We're no longer pursuing early deployment. This is a change from last year." Other SDI contractors and program officials said "early deployment is

dead", and other words to the same effect.

The delay is such that SDIO probably cannot make a significant start on deployment, even of the Phase I architecture, until at least 1998 at the earliest. Last year SDIO was seeking a Phase I deployment by 1994-95. The delay means Phase I deployment, if it happens, won't be "early" at all. In that sense "early deployment" is dead. The best that SDIO can do is to deploy a "thin" system in about the same time frame they had originally hoped to deploy a comprehensive defense.

There are several reasons for the demise of early deployment. First, an "early" deployment cannot happen because there will be no room in the defense budget for it. The last Five Year Defense Plan (FYDP) that was legitimately compiled in the usual manner allocates to SDI nearly $5 billion less than that required for Phase I to stay on schedule. And this shortfall is growing.

Secretary Carlucci says he must pare the FYDP by $300 billion. As a result the Administration reduced the FY 1989 SDI budget request by $1.7 billion from what was projected for FY 1989 last year. SDIO indicates that this kind of cut will occur in each succeeding year as well. The shortfall will increase when SDIO's $75 - $150 billion cost estimate for Phase I inevitably increases.

Secondly, prospects for early deployment are nil because there is no affordable way to launch the SDI Phase I system into orbit before the end of the century. This is addressed more fully in Chapter 5. Last year, SDI suddenly required an "interim launch vehicle" for Phase I deployment in the mid-1990s. No such interim launch vehicle is being developed now. As a result, no low-cost space launch capacity will be available until 1998 at the earliest and more likely the year 2000.

A third factor may be the Administration's failure to implement the broad interpretation of the ABM Treaty in 1987. In answers provided for the record from the March 19, 1987, hearing before the Senate Defense Appropriations Subcommittee, Gen. Abrahamson said:

> "The broad interpretation would allow the United States to retain the option to decide to deploy strategic defenses in the mid-1990s. Even under ideal conditions, the restrictive interpretation would delay deployment until the late 1990s."

This suggests that even if Congress had provided all the funding SDIO requested, SDI initial deployment would have been delayed until the late 1990s. The importance of moving to the broad interpretation on the SDI deployment schedule was described in detail in the classified Report to Congress on the Anti-Ballistic Missile Treaty, dated May 19, 1987, submitted by the Secretary of Defense. The unclassified summary of this report used the same words as Gen.

Abrahamson:

> "The broad interpretation of the ABM Treaty would allow the United States to retain the option to deploy strategic defenses in the mid-1990s. Even under ideal conditions, the restrictive interpretation would delay deployment until the late 1990s."

Not only was movement to the broad interpretation essential according to this document, but it had to occur within a very short window of time. The report says in an unclassified paragraph,

> "Any significant delay in implementing the broad interpretation of the ABM Treaty will result in increasingly detrimental consequences to the SDI program. These consequences range from further delays in the program and higher costs to the loss of deployment options, in the event of delays of a year or more."

This report was issued on May 19, 1987, so Phase I already may have lost deployment options. In a hearing on March 31, 1988, Sen. Johnston asked Gen. Abrahamson if this were so. He responded in writing, "...While the program has not yet reached this point, it will if current trends continue."

In contrast, a review panel for the Phase I decision, the Defense Science Board Strategic Air Defense Task Force Sub-Group on the Strategic Defense Milestone, stated in its letter report of August 13, 1987: "The activities that must be carried out over the next couple of years, however, should not be seriously affected even if the United States adheres to the narrow interpretation."

The fourth reason for early deployment's demise is the extremely optimistic schedule for progress in the technology. Phase I presumes the use of sensors never before built, rocket propellants never before used in space, and the construction of an unprecedented constellation of new systems.

When the Milestone I decision for Phase I was made last year, it did not include selection of the mid-course sensors. Thus, the Phase I architecture is almost certain to change. In fact, up to three additional components are strong candidates for inclusion in Phase I: AOA, HEDI, and GBR. The Phase I schedule assumes concurrent production of the BSTS and SSTS sensors (and GSTS, as well) -- that is, production would begin well before the development process was complete. "That's all slipped to the right now," we were told.

For these reasons we conclude that no "early" deployment is

possible in the sense of meeting last year's objective of a mid-1990s decision date. Phase I seems to us unlikely to be deployed before 1998 at the earliest, and we see signs of uncertainty about that. A fundamental change must occur in SDI's plans for a phased deployment, or in both the DOD budget situation and plans for follow-on launch capacity.

5. LAUNCHING SDI INTO SPACE

Dramatically reducing space launch costs has always been a prerequisite for a space-based missile defense system. In the late 1950s, when the Department of Defense first seriously examined proposals to place a ballistic missile defense (BMD) system in space (Project BAMBI (BAllistic Missile Boost Intercept)), the ability to launch objects into space inexpensively was considered vital to any such proposal. A 1960 report for the Director of Defense Research and Engineering said that such launch costs would have to be ten times lower to make a space-based BMD system economically attractive: launch costs would have to be reduced from $500 per pound, then the current cost, to $50 per pound.

Nearly three decades later, SDIO officials reached the same conclusion: SDI deployment would require development of space launch capacity having a tenfold reduction in launch costs. However, by then inflation had increased typical launch costs to $3,000 (Titan missile) to place one pound in orbit and $5,000 per pound if the Space Shuttle were used.

SDIO officials see the development of this new space launch capacity necessary for SDI deployment as a monumental undertaking requiring a "complete revolution" in America's space effort. While the U.S. launched a total of about 350,000 pounds into earth orbit during 1985, SDIO envisions SDI deployment as requiring as much as 5 <u>million</u> pounds in orbit per year. This is 14 times what was launched in 1985, the last year before the Shuttle disaster. The capacity of the U.S. to launch payloads into orbit would have to be expanded enormously while the cost would have to come down by at least a factor of ten.

According to SDIO's 1986 timetables, SDI deployment would not begin until the late 1990s and not be completed until about 2005, allowing time enough to worry about the launch system. So SDIO concentrated instead on the daunting task of developing the technology for the actual SDI components.

SDI's reorientation in 1987 toward Phase I deployment (in the early or mid-1990s) forced SDIO to address the space launch capacity issue as a high priority item. The 1987 "Capstone" report said:

> "While expanded numbers of current launch vehicles and facilities could satisfy the initial Phase I deployment, it would not be cost-effective nor would it meet the full Phase I requirement or any follow-on requirements. The SDI will require far greater launch capacity than the US has available."

The Administration announced a goal to develop a heavy lift launch vehicle (HLLV), renamed Advanced Launch System (ALS), by about 1998. Echoing the requirement of BAMBI nearly 30 years earlier, SDIO labeled this vehicle the "objective" vehicle, the objective being to reduce launch costs to orbit by a factor of ten. The very practical problem for SDI is that the cost-reduction technologies could not be pushed fast enough to make such a rocket available in time for early SDI deployment.

To support early deployment, rocket scientists were directed to seek to build an "interim" vehicle with as low a launch cost as possible. DOD estimated that a three-fold reduction in launch costs was achievable in time to satisfy the early deployment requirement. So SDI early deployment would have to be accomplished with a launch rocket having about a three-fold reduction in launch costs instead of a ten-fold reduction. The Capstone report said,

> "To meet Phase I deployment options, an interim mid-1990s ALS [Advanced Launch System] derivative, using the key technologies developed for the later version, will be required."

They also noted that SDI requirements will constitute potentially 80% of the nation's lift capacity.

To support this urgent priority SDIO sought an urgent supplemental appropriation of $110 million in the FY 1987 budget request for a heavy-lift launch vehicle and a ten-fold increase in the FY 1988 budget request as compared to the FY 1987 appropriation. In FY 1987 SDIO said it would need only $169 million in FY 1988 for space transportation technologies. Instead, SDIO requested $434 million for these activities in the FY 1988 budget.

The DOD issued a Program Research and Development Announcement (PRDA) for an ALS design study. A "Statement of Work" dated July 1, 1987, called for an objective vehicle by 1998 with a ten-fold reduction in launch costs. The document added, "The contractor shall design an interim ALS which is optimum to achieve the necessary launch capability

at a minimum cost, should an early capability (1994) be required."

Meanwhile, the Congress provided funds for an ALS in the conference report on the FY 1987 Supplemental Appropriations bill, but prohibited the program from pursuing an "interim" vehicle. It is worth noting that an Air Force general familiar with the program noted in retrospect, "We could have come nowhere near the cost-goal of the interim vehicle."

SDIO awarded the ALS contracts the day before the President signed the Supplemental into law (July 11). There was some indication that the Administration would proceed with the interim vehicle anyway, vital as it is to SDI early deployment. It is interesting that the Air Force General Counsel even argued, in a memorandum of July 17, 1987, that the prohibition on an interim vehicle could be circumvented by planning for the early use of ALS "components" that are consistent with the objective ALS goal of a tenfold reduction in launch costs.

In providing the supplemental appropriations for an ALS, Congress also required the Administration to submit a report detailing how NASA and the Air Force would allocate their resources for ALS. The Congress repeated this reporting requirement in both the FY 1988 DOD Authorization bill and the FY 1988 Continuing Resolution and limited the availability of funds for ALS until the report was submitted.

On January 4, 1988, President Reagan approved a joint NASA and DOD report on the Advanced Launch System which outlines the program structure, the joint DOD/NASA plan, and a description of certain Federal facilities to be used. If nothing else, getting NASA and the Air Force to agree on an integrated technology plan was, as described by one Air Force officer, "a monumental achievement."

Current Situation on ALS

By February of this year Air Force and SDIO officers involved in the ALS program were unequivocal about the fate of the "interim" launch vehicle:

> "There is no interim launch vehicle in any way shape or form... It's gone."

Furthermore, we were told that the ALS program is "not structured to support any kind of near-term launch" of SDI.

With the interim vehicle gone, the earliest that the U.S. will have the "objective" ALS vehicle would not be until 1998 according to knowledgeable Air Force and SDIO officials. And even this date is doubtful. Air Force and SDIO officials directly involved in the ALS program agree that even that date is "dicey" and "assumes that the dice

always come up seven," we were told. When asked about an IOC in 1998 - 2000, an SDIO official familiar with ALS said, "That is probably not realistic."

Even if the maiden launch occurs in 1998, it will be one and a half to two years later before the ALS system would reach its full annual launch capacity. Thus, with the current ALS program SDI cannot begin meaningful deployment until probably the year 2000. There simply will be no means of lifting the SDI weapons and sensors into orbit at affordable costs.

Are there other means of launching Phase I in the mid-1990s besides the ALS system? Air Force officers at Air Force Space Division said that one could start with Titan missiles but could not expect more than 20 Titan launches per year. More important, as soon as one failed there would be a down time of six months to figure out what happened.

One officer identified the problem in a nutshell:

> "Any vehicle not designed for high launch rates can't cope with failures and down time. It forces you to launch after a failure without knowing why you failed."

The ALS, on the other hand, would be designed for high launch rates and very high reliability. Asked bluntly whether Phase I could be deployed without ALS, the officer responded with a simple "No."

This point is amplified in the Report to Congress on the Strategic Defense System (SDS) Architecture, dated January, 1988, which states:

> "While current launch systems can begin SDS Phase I deployment, an ALS will be required for a cost-efficient, timely and complete SDS Phase I deployment. SDS would require lifting several million kilograms of payload to space, necessitating a flexible, low cost launch system [emphasis added]."

So essential is the interim vehicle to timely Phase I deployment that one SBI contractor says it is prepared to build its own dedicated space lift system to launch SBI rather than relying on existing Titan rockets or ALS. They propose building a two or three staged solid fueled rocket, that could carry one or two carrier vehicles into orbit -- a medium launch capacity of perhaps 5,000 - 14,000 pounds. This new rocket would have no other purpose (or capability) except to launch SBI. To save costs there would be no guidance system; the SBI carrier vehicle itself would guide the launch rocket. The contractor told us

they would need about one and half years lead time before making a full-scale development decision on such a system.

High ranking Air Force officers were also pessimistic about ALS achieving a ten-fold reduction in launch costs to $300 per pound, even by the turn of the century. In fact, they criticized the whole idea of focusing on $300 per pound as the ALS goal. We were told that the Air Force would not pack a space launch vehicle with many high value satellites just to reduce the average launch costs per pound to orbit. It may make sense if the Air Force is trying to pack in hundreds of SBIs on a launch vehicle, but not if the payload is one or two high value satellites. One Air Force general called the $300 per pound goal for ALS, " dumb as dirt... I kill captains and majors for that."

An Air Force officer at Space Division agreed that the $300 per pound goal was not realistic. "I don't think we can build a vehicle at $300 per pound." However, it was useful, he thought, as a goal to force people to think of revolutionary changes in how things are done.

One can understand the Air Force's skepticism in these matters. Perhaps they recall the Space Shuttle fact sheet the White House issued on Jan. 5, 1972, that said that the Space Shuttle would reduce launch costs from $600 - 700 /lb. down to $100 per pound in 1972 dollars. Currently, Space Shuttle launch costs are about $5,000 per pound.

Even in terms of 1972 dollars, today's Shuttle costs missed their original goal by a wide margin. We do not say that ALS would duplicate the Shuttle's experience, only that large doses of skepticism about ALS cost claims are in order. This skepticism is shared by the Strategic Defense Milestone Panel of the Defense Science Board, who in an unclassified paragraph states:

> "Plans for ALS as briefed to us include reusuables and launch rates which appear highly unlikely."

The briefings provided to us indicate quite clearly that the ALS program is no longer aimed at building a specific heavy lift vehicle. Rather, the ALS program has been restructured to be a technology development program that is aimed at producing a family of future launch vehicles. In fact the ALS program is so generalized that no decision is necessary until 1991 on the specific payload weight that ALS must be capable of lifting into orbit.

The briefings also confirmed that the Department of Defense has no mission that requires a 150,000 pound lift capacity other than SDI. (Last year the ALS was projected to have a 75,000 - 150,000 pound lift capacity.) In fact, an Air Force general familiar with future Air Force payload requirements said, "We don't have a need for more than 70,000 to 80,000 pounds in the foreseeable future." He added that,

"There are some notional things that could get us to 100,000 pounds." In a joint briefing by Air Force officers and an officer from SDIO we were told that even SDIO has no specific payload requirement at this point for a rocket with a 150,000 pound payload capacity.

However, in December, 1987, SDIO instructed the Air Force to plan for an ALS having a [ ] pound lift capacity to low earth orbit to accommodate the space-based chemical laser. Apparently, the official paperwork, a work product directive, which requires review and clearance at high levels has yet to be processed. When asked how this was possible, one Air Force officer explained, "Gen. Abe just short-circuited the system." Thus, the ALS family of vehicles has been expanded to include a [ ] capacity, or about [ ] the current launch capacity of the Space Shuttle to low earth orbit.

An Air Force chart entitled "Space Transportation Systems" shows the current schedule for ALS. An ALS family of vehicles ranging in payload capacity from 40,000 to 150,000 pounds would enter service about the year 2000. A follow-on to the Space Shuttle (Shuttle II) or the National Aerospace Plane would be available to carry 65,000 pounds beginning in the year 2005.

The hard fact is that significant reductions in future launch costs will require investments in technology to update the existing technology base. The current tech base for space launch vehicles is 15 - 40 years old, we were told. These investments will not come cheaply. According to unclassified answers he supplied for the record, Gen. Abrahamson said that the technology development and facilities for ALS would cost a total of $17 billion.

With the loss of the interim vehicle for early deployment, the Administration's enormous enthusiasm and big budget requests of last year for ALS have turned around. The actual FY 1989 budget request is only $200 million, while last year the projected FY 1989 SDIO budget request for Space Transportation and Support was $601 million, a reduction of over $400 million.

The Administration's projected funding requests for this program in coming years shows funding staying at about $200 million. This may well put the ALS program in jeopardy. An Air Force Space Division officer said, "$200 million per year will not do that program." What is needed now, we were told, is a Congressional commitment to the ALS program.

6. CHALLENGES to PHASE I DEPLOYMENT

In describing the Phase I architecture and the technical challenges involved in meeting the JCS criteria, SDIO and its contractors generally concede the technical challenge is significant but not insurmountable.

There are several dimensions to these technical challenges. The first is achieving the desired effectiveness level against today's Soviet threat. This is often referred to as the "non-responsive threat." It is unlikely that the Soviets would not respond to SDI, given 40 years of superpower history where each side has responded to steps taken by the other. The technical challenge of this "one-dimensional" threat is multiplied by the many directions that the Soviets could take in responding to our SDI.

1. Changes in tactics in employing offensive forces. (The Soviets could group their mobile missiles together to "punch through" a space-based defense, or they could launch a greater fraction of their missiles simultaneously - - a more stressing tactic for SDI.)

2. Deployment of more offensive forces of the kind they have deployed today.

3. Deployment of passive defenses against SDI (decoys, chaff, etc.) using current technology.

4. Deployment of active defenses against SDI (anti-satellite weapons, ground-based lasers, jammers, etc.) using current technology.

This list of "existing technology" directions is further magnified by the additional dimension of new technology. Technology is a two-edged sword. While it is often invoked to explain how SDI will deal with a particular problem, it too seldom is appreciated for the options it will open up for the offense. Thus new technology will open up new defenses against SDI, new tactics and offensive force capabilities. An especially important aspect of this is the inherent capability a Soviet SDI would have against our SDI.

Technical Challenges

Even if the Soviets did not respond to SDI, it would still represent an unprecedented technical challenge to U.S. defense ingenuity. Coordinating the successful development of all the SDI components, including the all-important BM/C3 function would, as then

Under Secretary of Defense for RDT&E Richard DeLauer put it, "be equivalent to or greater than 7 or 8 Manhattan projects."

Enumerating all the specific technology issues for Phase I is well beyond the scope of this report. Below we highlight just a few of them.

<u>SBI Rocket Motors:</u> There are important technical concerns with the propulsion systems used to power the flight of the small SBI interceptor rockets as well. One of the contractors is proposing to use liquid propellants for one stage and solid propellant for the other. Solid propellants are not as energetic as liquids and normally would impose a weight penalty for their use. However, the contractor is planning to use a special additive, [ ], that would make the propellant more energetic.

This entails several major risks. First is the concern that the solid propellant, when it burns, could leave a deposit on the sensor window and thus "blind" the SBI by its own exhaust. We were told that this is a major reason why another contractor has decided not to use a solid propellant second stage. As one SDI scientist told us, "Every ten years or so people rediscover [ ] and it looks good until they see its problems."

The second concern is that [ ] compounds are extremely toxic, several hundred times more so than arsenic, and there is no known cure for the disease it causes, [ ]. Moreover, it is carcinogenic. Use of [ ] creates health and safety concerns both for workers who fabricate the rocket motors and for those who would live "downwind" from the launch pads for SBI-laden launch vehicles.

While an environmental impact statement (EIS) has been performed for rocket tests to be conducted in California, none has been filed for deployment. Given the large number of launches needed to deploy Phase I, launch vehicle failures are a distinct possibility. It has been estimated that [ ] the SBI weight would increase by 20 - 30%, a substantial effect given the importance of SBI's weight to its overall cost.

<u>SBI Warhead Weight</u>: A crucial factor in SBI's performance is the weight of the kill vehicle warhead. The heavier the warhead weight, the slower it will travel, given a specific amount of rocket propellant. While the Fletcher Study indicated that the warhead weight should be [ ] or less, the warhead weight for SBI in Phase I is expected to be about [ ]. The desired [ ] weight will not be achieved until a future version of SBI, probably in a later phase, if then.

SBI Timelines: The SBI velocity question is directly related to a fundamental technical challenge facing SBI, what can be called the "beat the clock" problem. Time is essential for SBI, as it has at most only [ ] [ ]. There are only a few minutes more in the post boost phase to intercept [ ].

It can take up to [ ] seconds or more for a missile to rise above the clouds (which absorb a missile plume's short wavelength infra-red radiation) so that a warning satellite like BSTS can detect it. It takes about another [ ] seconds for BSTS to establish a track file sufficient for SBI to calculate an intercept point. [ ] seconds or more is required for the SBI to be ejected by the carrier vehicle and to drift far enough away from the carrier vehicle so the SBI's ignition and boost do not interfere with the carrier vehicle's optics and other systems. These and other factors, such as allowing human interaction with the system, result in total delay times of [ ] seconds.

Accordingly, SBI will have only [ ] seconds to intercept Soviet ICBMs during their boost phase. SBI could have as much as [ ] seconds more to intercept MIRVed ICBMs during their post-boost phase, although some of the missile warheads would have been dispensed from the PBV. As we will see, the Soviets can take steps to shorten both the boost and post-boost phase signficantly. For attacks against Minuteman missile fields, the type of [ ] attack that most worries U.S. defense planners, the post-boost burn time for the PBV is [ ] seconds even now, because the close spacing of Minuteman ICBM silos does not require the PBV to disperse its warheads very much.

A more complete picture of the timing problem facing SBI is seen in Table 2, which shows the time available to SBI to attack several current and hypothetical future Soviet missiles. The "SS-MMIII", "SS-Trident I", and "SS-Trident II" are hypothetical future Soviet missiles that have the same characteristics as the U.S. missiles after which they are named. [ ], or as Phase I would just start to be deployed. The [ ] is a faster-burning Soviet ICBM using [ ], when Phase I would still be in the process of being deployed.

For a distance of [ ] kilometers to its target, an SBI moving at [ ] would require [ ]. The timeline chart shows that SBI has significant potential against a missile like the [ ] as it exists today,

especially during the post-boost period. The [ ] is less vulnerable during the boost phase, but more so during post-boost. SBI is completely ineffective against the [ ], as well as the [ ], designed about [ ] years ago. SBI would have almost no boost-phase intercept capability against any of the current generation U.S. missiles or [ ], unless a carrier vehicle's orbital position happened to be quite close to the missiles when they

Table 2: TIME REQUIREMENTS FOR SBI,
(seconds)

Missile	Burn Time	Bus Time	SBI Delay	Time Available for SBI to Reach Target During:	
				Boost	Post Boost
SS-18 (Mod 4)					
SS-N-20					
SS-24					
SS-25					
SS-MMIII			DELETED		
SS-13					
SS-Trident I					
SS-Trident II					
SS-24 (retro)					
SS-25 (retro)					
SS-2000					

were launched. By the time Phase I could be fully deployed, the Soviets could be deploying MIRVed ICBMs that would be virtually invulnerable to SBI.

If SBI receives accurate targeting and discrimination information from SSTS, it can aim at individual Soviet warheads, but the pay-off for killing a single RV is much less than for killing [ ] and other countermeasures it might have.

Human Control Over SBI? As difficult as this beat the clock problem will be for SBI, there is a crucial management issue that complicates this problem even more: the "person-in-the-loop" problem. Early studies of space-based interceptors, including a 1981 Air Force study and the Fletcher Study, recognized that to be effective against a massive Soviet launch of missiles, SBI-like systems would need to have an "automated command and control system." In other words, they would need to be able to begin firing autonomously, without waiting for human intervention, if they were to have a chance of destroying an appreciable number of Soviet ICBMs in their boost phase.

To its credit, SDIO has recognized the danger inherent in such a command and control framework and has assured Congress that a positive human decision will be required before an SBI system, or any other lethal component of SDI, could be activated. To reinforce this point, Congress has mandated, in P.L. 100 - 180, that SDIO cannot plan for, or support, command and control systems for SDI that would permit the system "to initiate the directing of damaging or lethal fire except by affirmative human decision at an appropriate level of authority."

Precisely how much time this would add to the delay before SBIs could be launched depends on what the "appropriate level of authority" is, and a host of other factors. Some SDI engineers believe that the delay would be relatively short, about [ ] seconds. Others believe that it would be as much as [ ] seconds. In the latter case SBI's effectiveness in the boost phase is nearly eliminated, and its post-boost effectiveness is seriously degraded, even without Soviet countermeasures.

There is a way, SDIO officials contend, to buy perhaps [ ] seconds of extra time for SBI. SBI could be launched automatically without human intervention, but the final inflight "hand-off" of targeting information necessary for the SBI to home in on its target could be withheld until the necessary human authorization is obtained. Even if this is technically feasible, however, it may not be desirable because of the potential for "spoofing" the system or jamming the

transmission of the vital targeting information to the SBI.

In addition, this would still appear to violate the "person-in-the-loop" law which prohibits the "initiation" of the direction of lethal fire without human intervention.

Fitting a human decision into the command and control structure for SBI raises several additional problems. For one, there would be no time to consult, and obtain the approval of, the President in the event of a "bolt out of the blue" attack. More likely, approval to activate the Phase I defenses would have to come from a prior designee of the "Space Defense Commander".

Another problem is that SBI probably cannot attack the <u>first</u> missiles that are launched. As one SDIO official candidly admitted, "we won't get the first few horses out of the barn." This suggests one Soviet countermeasure might be to "send all their horses out of the barn" simultaneously in a "spike" attack using a large number of their missiles. While this strategy would penalize the Soviets in targeting flexibility, it might enable them to "get the drop" on SBI.

This problem also suggests that SBI would be of little value against an accidental or unauthorized launch, which by definition consists of an initial launch and no more. In the event of a threatened blackmail unauthorized launch, however, the necessary authorization might be obtained in time.

<u>SBI and Rocket "Hardbodies"</u>: Another of SBI's technical challenges is to be able to distinguish the rocket or PBV from its exhaust plume. Although the interceptor's infra-red sensors focus on the hot plume, not the rocket itself, the guidance system must ensure that the SBI collides with the rocket, not just the plume. Here a miss is as good as a mile because SBI has no explosive charge. Relatively little is known about plume physics, and a good deal more research is needed.

<u>SBI Kill Probabilities</u>: What is the probability that a given SBI will destroy its target? SDIO officials and contractors gave a wide variety of answers, all of them extremely high -- a [ ] kill probability. If correct, SDI would have a higher probability of kill than every surface-to-air missile in the U.S. inventory, including Stinger, whose targets are only a very few, not hundreds or thousands, of miles away. (It may be that these high numbers for SBI do not represent a <u>systems</u> probability of kill.) One contractor conceded in response to a question that the probability of kill could be lower. While the accuracy of SBI is projected to be plus or minus [ ], this cannot be considered firm, especially in light of potential Soviet countermeasures. Reaching the "kill probability" levels SDIO envisions will be a formidable technical challenge.

<u>SBI Velocity</u>: The velocity of the SBI interceptor is crucial to its

performance. If SBI is not as fast as planned, it will have a smaller effective range. More carrier vehicles loaded with SBIs would thus be required to provide the same level of coverage, increasing the cost. The Fletcher study indicated that the velocity of the SBI should be [ ] against current threats and against fast-burn boosters SBI velocities of at least [ ] are desired. The system briefed to the Defense Acquisition Board assumed a velocity of [ ], though in briefings we received from SDIO and associated contractors, figures for SBI velocity ranged from [ ]. If [ ] is not used, SBI's velocity may be only marginally adequate even against current boosters.

Soviet Countermeasure Challenges

As this report suggests, the likely date for a first deployment of Phase I appears to have slipped by several years. This slippage comes at a time when serious questions are being raised about the effectiveness of Phase I in general and about SBI in particular in the face of modest increases in the Soviet threat. We heard from one SDI scientist that the "Soviets can overcome (SBIs) in a timely and cost-effective manner."

These questions about SBI's effectiveness flow from increasingly sophisticated analyses of likely Soviet responses to SDI. These questions are not just a recent phenomenon. The 1984 Fletcher study for example provided extensive descriptions and diagrams of potential Soviet countermeasures.

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While SDIO has complained about its critics creating a "Threat of the Month Club", [ ] provides ample justification for a lengthy menu of possible Soviet countermeasures. Additional countermeasures also exist such as [ ] and other techniques for missile plume modification, external coatings, radar absorbing materials for RVs, booster hardening, [ ], space-based nuclear weapons, [ ], chaff and aerosols, and others. We discuss just a few of these potential countermeasures.

Many of the technical challenges to Phase I, in terms of countermeasures and fundamental technology, deal with the issues of survivability, effectiveness, and cost. Not surprisingly, these are the issues addressed by the Nitze criteria.

Survivability Challenges

One of the crucial vulnerabilities for the proposed Phase I architecture is its heavy dependence on a relatively small number of sensor platforms. In this regard, Phase I is similar to the old Safeguard ABM system, which likewise depended on a very few sensors (in this case radars) for the system to operate.

The key sensor platforms for Phase I are BSTS and SSTS. [ ] said Phase I will have [ ] BSTS satellites and [ ] SSTS satellites. Given their orbits, at any particular time about [ ] of the SSTS satellites and perhaps [ ] of the BSTS satellites will be unable to sense a Soviet ICBM attack. Thus, Phase I would be dependent upon a few sensor satellites. These would be extremely lucrative targets for the Soviets to attack.

Of the two satellite types, [ ] is more vulnerable. Orbiting at about [ ] kilometers, instead of [

] would be well within range of Soviet [ ], ground-based lasers, or a rudimentary Soviet version of SDI.

[ ] poses a major threat to the Phase I architecture. It is not technologically demanding to design, in part because [ ] as a non-nuclear kinetic kill interceptor like ERIS, which SDIO seeks to make for $1 million each in large quantities. [ ], a step that would be very stressing to the defense. [ ]

[

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]

Although not optimal, [ ]. If the Soviets could do just half as well as SDIO's goal of $1 million per ERIS and build one for $2 million, and they could build [ ], a typical cost, they could build a fleet [ ] for about what the Reagan Administration has requested for SDI funding for FY 1989 alone.

A somewhat more sophisticated [ ] by SDI scientists, could complete its boost phase in [ ] seconds, making it virtually immune to attack in the boost phase by SBI. SBI could try to defend itself and other Phase I elements [ ], but this would both detract from SBI's anti-missile mission and have only limited effectiveness in any event, especially if the [ ] had a short boost-phase.

Even more pernicious to the survivability of Phase I is the challenge of [ ] decoys. Unless destroyed during its short boost-phase, [ ] that could threaten to overwhelm any [ ] capability of a Phase I SDI architecture. Scientists working on this problem believe that it should be possible to put [ ], though at increased missile cost.

It is important to remember that [ ] would not have to destroy all the space-based systems deployed by SDI. Attacking the key components of the system, only those in a position to threaten the attacker's missiles, would be sufficient.

If each [ ] had as little as a 5% chance of destroying [ ], a very conservative estimate, then an [ ] chance of surviving against an attack [ ]. This figure drops to only [ ] kill capability is still a modest 10%. Thus, only [ ] could severely limit Phase I, which has a constellation of [ ] satellites, because the [ ] which would be in range to observe a Soviet ICBM attack.

SBI also faces serious survivability problems as well. Its carrier vehicles would be quite vulnerable to precursor [ ] both in terms of physical survival and the disruption in the [ ] environment in which SDI would be operating. SBI likewise would be vulnerable to ground-based lasers and, not the least, to a Soviet version of SBI, especially if we shared the technology with the Soviets, as the President has suggested. The carrier vehicle has an inherent self-protection capability [ ] hostile SBIs, namely the kill vehicles each CV carries, but serious problems still remain.

Conceptually, the problem is similar to that of opposing silo-based MIRVed ICBMs -- just as an SS-18 can use its 10 warheads to destroy more than one silo-based MX, a carrier vehicle has an inherent capability to destroy more than one hostile carrier vehicle. [ ] as well to increase the probability that they could destroy their targeted carrier vehicles.

Last year in fact, the Strategic Defense Milestone Panel of the Defense Science Board noted that [

]

BSTS has some level of safety by virtue of its [ ] in Phase I -- [

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].

We were told that it would take a minimum of [ ] for a Soviet [ ] ICBM to reach the [ ], so that such an attack might provide some warning. If U.S. forces were already at alert, the benefit of this warning could be small. And if

the Soviet ASAT has any kind of homing on command guidance update capability, [ ] would probably be of little value to BSTS.

Given the crucial importance of BSTS to Phase I, it would be [ ] the expenditure of many missiles for the Soviets to attack BSTS. And if they [ ] to achieve their objective, the task may be [ ] to them.

A ground-based laser would probably not be able to destroy a BSTS satellite, or even damage its optics. It might interfere or prevent BSTS from performing its role for [ ] minutes. [

].

Fast-Burn Boosters

Another well-known countermeasure to boost-phase defenses like SBI is the fast-burn booster. Booster burn times can be significantly reduced at a small penalty in performance, thereby shortening the amount of time available for SBI to attack the missiles. SDIO has tended to downplay this threat, arguing that it would be difficult to reach burn times [ ] seconds versus today's times of 200-300 seconds. They also argue that SBI can attack the RV-dispensing bus (PBV) in the post-boost phase and thus still achieve the JCS-required attrition levels. These arguments are correct only [

] could produce.

For example, SDI scientists who briefed us showed [

].

[

].

These "modified burn boosters" would increase SBI's [ ] absentee ratio even more, thereby reducing SBI's effectiveness or driving up the number of SBIs required.

We note that the booster burn-time of the Trident I and Trident II

missiles are significantly less than the minimum SLBM burn-time [ ] that SBI can engage in the boost phase. That report said, "...Phase I space-based interceptors can engage intermediate-range ballistic missiles (IRBMs) and SLBMs with booster burn times in excess of [ ] seconds ..." The burn-time for Trident I and Trident II is [ ] seconds.

The time it takes for Soviet missile PBVs to dispense their warheads can also be shortened considerably. When the current PBVs were designed, there was no need to dispense the warheads quickly, and so lengthy PBV burn times which had some benefits of their own, were incorporated into the design. This, too, can be changed and the burn/dispensing times substantially reduced. These "modified burn buses" would also cut deeply into SBI's ability to kill RVs.

Reducing the burn times of boosters and buses will seriously erode Phase I effectiveness. According to one top contractor scientist with decades of experience in ballistic missile defense, "As they [the Soviets] go into these programs, they begin to eat our lunch."

[ ]

Essential to SBI effectiveness is the early calculation of a precise missile trajectory, so that the SBI vehicle can be directed to a fairly precise point in space. If the target missile [ ] in the boost phase, the SBI would need an update as to the trajectory [ ].

The SBI envisioned by SDIO has been given a significant "divert" capability to deal with this counter, though SBI is dependent upon receiving updated information on the hostile missile's new trajectory from the carrier vehicle. Preliminary assessments of this problem suggest that the divert capability embodied in the SBI technology under development would be sufficient to counter [ ].

The same does not appear to hold true if the targets are solid propellant boosters. By their very nature, solid propellant missiles are less fragile than liquids and are capable of sustaining more g's in [ ] their optimum trajectories. In fact, modern U.S. missiles, such as [ ], have a built-in [ ] enables them to dissipate excess energy without having to resort to blow-out ports or other thrust termination techniques. With [ ] attacking a set of shorter-range targets [ ] to enable it to avoid overshooting its target.

It is interesting to note the [ ] originally was conceived by a

Navy scientist in the early 1970s, before the ABM Treaty, precisely as a countermeasure to a possible Soviet [ ] missile defense. The ABM Treaty made this step unnecessary, but it was resurrected for reasons of pure operational simplicity. Nonetheless, it was suggested to us by a senior Navy official as an effective [ ].

[ ]

Another possible countermeasure for the Soviets would be to develop [ ] missiles. By flying in [ ]. It is analogous to a catcher in baseball throwing a ball [ ] when he tries to throw a runner out stealing second base [ ]. The Phase I SBI would have difficulty dealing with such missiles because of their [ ].

[ ]

This is a modified version of a [ ] As one noted SDI scientist has pointed out, both superpowers have demonstrated the ability to launch payloads efficiently into orbits that [ ] SBIs could intercept them. [ ] Soviet air defenses.

[ ]

Two tactical countermeasures that could be used by the Soviets are to launch a [ ], so that fewer SBI carrier vehicles would be able to engage them. One SDI contractor has estimated that the Soviets could launch [ ].

The Mid-course Discrimination Challenge

One of the fundamental technical challenges facing SDI's Phase I is the problem of mid-course discrimination. As SDIO states [ ], "[d]eveloping a capability for mid-course discrimination is recognized as essential to meeting the SDS [Space Defense System] mission." Few issues in our review evoked as much controversy, disparate technical opinions, or professional parochialism

as did this.

The issue is central to SDI's feasibility, especially in considering reactive threats where the Soviets have the option of considerably shortening the boost and post-boost phases of their missiles. If faster-burning boosters and buses prevent most boost-phase intercepts in Phase I, an inability to distinguish RVs from decoys during mid-course would rule out most mid-course intercepts as well, drastically reducing Phase I's effectiveness.

There appears to be little doubt that the Soviets would be capable of loading a sizable number of decoys on their ballistic missiles. Missiles like [ ] already have excess throw-weight and will have still more in follow-on versions, according to the Defense Department's Soviet Military Power 1987. Thus, the numbers of decoys could run quite high. Simple balloons shaped like re-entry vehicles could be very light and loaded on [ ] in great numbers. We were told by re-entry vehicle design experts that it is easier to construct a warhead-shaped balloon, using just three pieces of material, than it is to construct a sphere, which requires many more pieces of material.

Such decoys could be distinguished from real RVs in several ways, most prominently by the rate at which the surfaces of the two types of objects cool down in the vacuum of space. The heavy RV would cool much more slowly than a light decoy, which means its infra-red signature would diminish more slowly. These differential infra-red signatures could in theory be detected by LWIR sensors onboard SSTS and GSTS.

Some SDI scientists having experience in designing not only U.S. RVs but replicas of Soviet RVs for test flights have proposed that this difference in cooling rates between real RVs and decoys could be muted by [ ] and point out that it is not a particularly difficult step technically.

In theory both [ ] RVs and [ ] decoys would then have similar infrared signatures. Experiments have shown that the cooling profiles for a [ ] RV and [ ] balloon replica are almost identical. A number of these nationally reputed scientists, along with some personnel from the contractors and the national laboratories, believe that this would be so effective that it would be virtually impossible to discriminate with passive (IR) means among the many objects in the mid-course threat cloud. These scientists also argue that discrimination using radar will not help. [ ] would provide virtually the same radar return for a decoy as an RV.

SDIO and other officials counter that [ ] radars

could discriminate between warheads and such decoys by observing the motions of the objects in space. Decoys, being much lighter, would oscillate or tumble differently than warheads, and this variation in motion could be detected with [ ] radars. Yet some scientists respond that by applying [ ] techniques the Soviets could make their warheads behave in the same manner. This process of measure, countermeasure, counter-countermeasure, goes on endlessly and is characteristic of the evolution of SDI.

The "mid-course pessimists" maintain that interactive discrimination will be necessary, in which case the objects to be discriminated are physically disturbed, and the reaction of each to the disturbance is observed. For example, a laser beam striking a light decoy would displace it more than the same beam striking a much heavier warhead.

Methods for interactive discrimination, with the possible exception of a first generation space-based chemical laser are not envisioned until the [ ]. If [ ] decoys and RVs can defeat passive discrimination methods, and [ ] and other techniques can defeat active discrimination, then sensor platforms like SSTS and GSTS would be much less effective, and Phase I effectiveness would fall dramatically.

On the other hand, SDIO, some Air Force officials, and several contractors firmly believe that mid-course discrimination can be achieved in Phase I. These "mid-course optimists" believe that passive means can and will be developed that will successfully discriminate between RVs and decoys, [ ]. They point to the Delta 181 experiment as providing evidence of this though they do not provide details as the Delta 181 data is still under review. They also maintain that active sensors will be useful as well for discrimination.

While radars in the past have been foiled by the use of chaff and metallized balloons, these officials point out that the [ ] of the radars envisioned, including laser radars, will make it possible to observe detailed movements of objects in the threat cloud, and the differences in these [ ] between decoys and RVs would be detected. In addition, decoys passing near or through the [ ] would be displaced much more than a heavier re-entry vehicle. "SSTS will be able to discriminate for the next 20 years," one contractor scientist claimed.

The mid-course pessimists respond that these movements of objects in the threat cloud can be blurred through a variety of means, including [ ] techniques that would give RVs the same [ ] as decoys. In addition, an [ ]. As for Delta 181, the mid-course pessimists are skeptical, but say they

will reserve judgment until they see the full flight data and can determine if refinements in shroud design could make these countermeasures effective.

The Soviets are aided by the fact that [ ]. Thus, our SDI sensors will not be able to search for a [ ]. Whether the Soviets intended this or not is not known. This characteristic of Soviet re-entry vehicles makes the mid-course discrimination problem more difficult for SDI.

Scientists working on the decoy problem believe that [ ] can be made that weigh slightly more than a pound each, enabling the Soviets to put as much as [ ] without offloading any warheads. The decoys must be deployed quickly and scientists believe that can be done at a rate of [ ] from each PBV. This step alone could add [ ] objects to the "threat cloud" facing Phase I. It is not unreasonable to project that a research program tasked to develop lighter materials could increase this figure significantly. As we have suggested elsewhere, technology is a two-edged sword.

Enabling other Soviet missiles to carry such penetration aids would increase the number of objects in the threat cloud still more. And if mid-course sensors end up being less effective than current plans project, simple balloon decoys, which are lighter still, could swell the threat cloud of objects confronting Phase I far more.

There is a legitimate difference of technical opinion on the vitally important issue of mid-course discrimination which can be resolved by further study and experimentation. Essential to this process is a realistic funding level for countermeasures research and a "level playing field" for both sides to test their technologies against one another. In this regard, it is particular disturbing to note the gross imbalance in spending for research on defensive systems in comparison to research on offensive countermeasures.

Current funding of countermeasures research is a tiny fraction of SDI's budget. Particular countermeasures projects have been cancelled. Not only does this rob SDIO, the Defense Department, and the Congress of key information needed to make informed decisions on SDI, but it also denies us information that may well be needed in coping with Soviet defensive developments, which the Reagan Administration regularly trumpets.

The Administration cannot have it both ways. If the Soviets are truly in a position for a rapid breakout of the ABM Treaty, as the Administration darkly suggests, then their failure to conduct additional countermeasures research is perplexing and disturbing. If

the situation is not so bad, then the Administration should scale back its rhetoric on this issue.

In either case, it is essential that both sides of the mid-course debate be allowed to compete on a level playing field. Shortchanging countermeasures research would seem especially shortsighted, given the critical importance of the mid-course discrimination question and the unfettered and aggressive countermeasures research program that the Soviets would undoubtedly undertake as a response.

The challenges facing Phase I are well known within the SDI community. The following chart from a national laboratory, called "Basic Truths", illustrates the difficulties facing kinetic energy weapons (KEW), a crucial component of Phase I.

The countermeasures problem is best summed up in the words of two SDI scientists. The one told us, "I would say it is modest" what the Soviets would need to do to defeat SBI in the boost phase. Or, as the other SDI scientist candidly put it, "I'd rather have the Soviets' problem of figuring out how to defeat SDI than our job of trying to figure out how to make it work."

Basic truths

- KEWs can counter [deleted] with cost effectiveness on the margin in the boost phase
- KEWs can be countered in the boost/post boost phase
- KEW marginal cost effectiveness [deleted] in the boost phase appears unattractive – need to switch to midcourse – need discrimination
- KEWs may provide enduring defense in the midcourse if discrimination is possible
- Long term viability of KEWs probably depends on viability of DEWs to do interactive midcourse discrimination
- As DEWs mature, legacy of KEWs could be continued midcourse defense as well as counter-counter defense against [deleted]
- DEWs for discrimination should have the potential to evolve into lethal defensive weapons, if possible

7. PHASE I COSTS

SDI Funding in the Past

Six days after President Reagan gave his now famous "Star Wars" speech, reporters asked him if he wanted to increase the budget for ballistic missile defense research. He responded that the budget already had about a billion dollars ($900 million) in it and that was sufficient. Asked if he wanted the budget doubled or tripled he said, "I don't see any need for that, no." He added, "This is not a crash program."

Despite this Presidential assurance, only two years later he requested a budget level 4 times that earlier figure. And today Congress is funding SDI at more than this quadrupled level.

Nevertheless, the Administration has intensely criticized the Congress for underfunding SDI over the past five years. President Reagan labeled Congress' actions "irresponsible". Is that criticism legitimate?

In order to plan an orderly research program the President requested in a national security study directive a study on the potential for ballistic missile defense. The result was the seven volume, classified, Fletcher Study, published in February, 1984. Well over fifty of the nation's leading experts participated. This seminal work included a detailed technology roadmap for performing the research that would lead to a full-scale engineering development decision on SDI.

The President specifically requested two research programs, one technically aggressive, the other assuming fiscally constrained resources. The study was intended to provide guidance for decisions on the funding commitments for SDI for the Five Year Defense Plan. Therefore, the report included a year-by-year breakout of how much funding each technology and the program as a whole would require.

In response the Fletcher report presented two options. The first was a "technology limited" program, what is commonly known as a "crash program", perhaps the best known example being the Manhattan Project. The Fletcher panel recommended this option but provided, as the President directed, a second option, a "fiscally constrained" budget plan that maintained the same overall technical approach as the crash program but which stretched the length of the research program by "at least one to two years".

It is interesting in retrospect to note that to date Congress has

in fact (unknowingly) provided SDI funding levels that very closely match what the Fletcher panel recommended for a "fiscally constrained" research program. Over the years FY 1984 - 1988 Congress provided 92% of what the Fletcher report recommended in total for those specific years for a fiscally constrained budget.

The panel recommended a total of $14.3 billion (adjusted to then-year dollars), and Congress appropriated $13.1 billion during those first five fiscal years.

If Congress is to be faulted in its funding of SDI, it is only for refusing to fund a crash program for SDI. In a severely constrained budget environment Congress essentially met the funding requirements defined for the President by his own panel of experts as adequate for a fiscally constrained SDI research program.

What in fact did SDI need to complete its research program, so that the Nation could make an informed decision on full-scale engineering development of SDI technology?

Shortly into the SDI program, the full-scale engineering decision date on SDI was said to be the early 1990s. According to figures from the DOD Comptroller, by 1985, SDIO's projected budget request from FY 1984 - FY 1990 (excluding DOE) was $33.122 billion. In the last year of this estimate the FY 1990 budget is projected at $8.634 billion for the DOD portion of SDI alone. The budgets for succeeding years would be expected to rise even higher until an FSED decision.

That $33.1 billion figure should be contrasted with DOD's pre-SDI projections for ballistic missile defense (BMD) research over the same years FY 1984 -FY1990. Just prior to the President's first SDI speech, DOD provided the Congressional Budget Office with out-year budget projections for BMD research during those fiscal years. The total pre-SDI estimate was $ 12.182 billion for the DOD portion of SDI (excluding DOE), or slightly more than one-third of the post-SDI estimate of $33.1 billion. In other words, based on budget projections issued in 1985, the SDI program nearly tripled what the Administration would otherwise have requested for BMD research during FY 1984 - FY 1990.

It is important to consider the magnitude of these numbers. While much has been made of the cost of deploying SDI, less attention has been paid to the cost of just making an informed decision on whether to proceed to system development. Research costs totaling $33 billion for a program are unprecedented. That figure rivals the deployment costs of major strategic systems such as Midgetman and the B-1.

Current Cost Projections for SDI Research

The $33 billion figure turns out to be substantially less than what SDIO will require in total to complete the research to reach a full-scale engineering development decision on just Phase I deployment. The Strategic Defense System Concept Paper of August 1, 1987, which formed the basis for the Milestone I decision on Phase I, lays out year-by-year budget requirements for SDI through FY 1992, the projected date as of last August for conclusion of the demonstration/validation phase for Phase I. The numbers are not only sobering, they are convincing evidence that SDI is pursuing a course of action that cannot be sustained.

It is quite clear that if SDI stays on its chosen course over the next several years, then this research program will almost certainly exceed the research budget for all our strategic offensive programs combined -- that is, bombers, air-launched missiles, ICBM's and submarine launched ballistic missiles.

The Strategic Defense System Concept Paper, dated August 1, 1987, [ ] shows that the Strategic Defense System cost estimates for FY 1988 - FY 1992 total [ ] billion. Adding what has already been appropriated for SDI, the total SDI research program from SDI's inception through a milestone II decision on development of Phase I will be about $50 billion. This is roughly comparable to the entire projected acquisition cost for the B-2 "stealth" bomber. If SDI proceeds on schedule by FY 1992 the annual SDI budget request would be $11.5 billion or more than either the Army or the Navy now spend on RDT&E for all their programs. Table 3, Funding Summary, taken from this document, shows the situation on a year-by-year basis.

This chart also breaks the costs for each year into what is required for the demonstration and validation of Phase I systems and what is required for what SDI calls its "technology base" research effort for all successive phases of SDI. This technology base effort includes all the research on the lasers, particle beams, and even the kinetic kill weapons that are not included in Phase I.

Two points should be made about the technology base costs for SDI if the Nation follows the fiscal course the Administration has laid out for the Strategic Defense System. First, the Department of Defense would be spending far more on what SDI calls its tech base research than for all the other tech base programs combined of the Defense Department. The total amount appropriated for technology base research for the entire Department of Defense in FY 1988 was $3.3 billion. The Administration's FY 1989 request for tech base research is $3.277 billion.

Second, it is clear that SDIO will be doing very well indeed if Congress appropriates for SDIO as a whole (including DOE) what SDIO

TABLE 3. FUNDING SUMMARY (U)

(MILLIONS OF THEN YEAR $)

SDS ELEMENTS	FY88	FY89	FY90	FY91	FY92	FYDP TOTAL
ERIS Dem/Val	177	248	295			
MSS Dem/Val	185	235	425			
SBI Dem/Val	235	290	360			
BSTS Dem/Val	247	334	496			
SE & SI	37	53	452			
ALS	289	453	608			
BM/C^3 Dem/Val	165	196	415			
PHASE I ELEMENTS Dem/Val SUBTOTAL	1,335	1,809	3,051			
TECH BASE	3,890	4,470	5,620			
TOTAL	5,225	6,279	8,671			

projects it needs for just the technology base for SDI. The Congress provided a 12% increase in SDI's budget for FY 1988. If the entire SDI budget (including DOE) were applied to SDI technology base activities, it would have to rise more than 12% every year to meet what SDIO projects it needs for its technology base.

This suggests that, barring some national emergency or a dramatic change in the deficit situation, a robust research program for technologies in phases beyond Phase I may be all that can be realistically funded in the future. There won't be enough resources in DOD's budget to fund demonstration and validation of Phase I as well as a technology base effort. If SDIO were to drop the Phase I demonstration and validation programs altogether, then based on current funding trends it would probably still have difficulty funding just its technology base requirements for later phases if the Strategic Defense System schedule were maintained.

It is not clear that even the Reagan Administration's projected defense budget has the resources to meet the [ ] specified funding requirements for Phase I. The [ ] numbers for Fiscal Years 1990-1992 total nearly [ ] what is included for SDI in the Reagan Five Year Defense Plan (FYDP) for those same fiscal years. The FYDP to which we are referring is the last one that was assembled (about two years ago) from the ground up in the traditional manner. Apparently last year's move toward early deployment necessitated even higher SDI funding than was projected when the FYDP was assembled.

Yet the FYDP situation is doubly difficult because that Five Year Defense Plan was put together <u>before</u> Secretary Carlucci determined to lower the real growth rate for defense to 2%, necessitating reduction of defense programs for FY 1990-1993 by $300 billion in the FYDP. Once the Reagan Administration assembles a new FYDP there will be even less room for SDI than in the old one.

In recent months the Defense Department saw the gap between the funding SDI required for the course it had set and what was realistically possible. Thus, the Administration reduced their FY 1989 budget request for SDI from $6.7 billion, last year's FY 1989 projection, to $5 billion, a cut of $1.7 billion. In our budget briefings we were informed that this step is likely to be extended for the outyears, roughly a $1.7 billion cut in each year from what was otherwise laid out [ ]. This comports with General Abrahamson's statement in a recent briefing to Hill staffers that because of the budget difficulties he has had to reduce SDI's outyear budget projections for FY 1989 - 94 by a total of about $8 billion. This and prior funding cuts have delayed the program by one or two years.

Even a cut of this magnitude will not bring the SDI funding

requirements down to realistic levels, given the current budget situation. For example, reducing by $1.7 billion [ ] funding requirement projected for FY 1990 for Phase I would still leave a $7 billion requirement for FY 1990, or more than a 30% increase in funding from the actual FY 1988 appropriation for <u>each</u> of the next two years. The costs soar from there. The table below indicates the annual funding levels that SDI would require even after a $1.7 billion reduction in each year.

Reduced SDI Budget Requirements
(in billions)

FY 89	FY 90	FY 91	FY 92
$4.6	$7.0	[ ]	[ ]

Clearly, completing the research leading to the development decision on Phase I will require unrealistically large funding increases for SDI. The one to two year delay recently incorporated into the schedule helps, but we believe the budgetary requirements are still unmanageable. Stretching out the research and delaying the schedule for Phase I deployment may help with the funding problem for now, but it comes at a severe price - - Phase I's useful life in the face of Soviet countermeasures shrinks even further.

Phase I Deployment Costs

The Administration's cost estimates for Phase I have spiraled upward at a dizzying rate in less than a year. These estimates are likely to grow further as not all costs are incorporated and there are highly optimistic assumptions built into them.

On March 19, 1987, Gen. Abrahamson testified that achieving a Phase I deployment would cost $40 - 60 billion (in 1985 dollars). In a September, 1987, CBS interview, Gen. Abrahamson raised his estimate to "$70 billion to well over $100 billion for an initial, partially capable but very impressive deployment". News reports indicate that the new figures were based on analyses prepared for the Defense Acquisition Board.

In February, 1988, Gen. Abrahamson told reporters and Congressional Research Service (CRS) personnel that the cost had risen to $75 to $150 billion (in 1988 dollars). The CRS reported that this figure included demonstration, validation, full-scale engineering development and production of Phase I.

In our briefings we learned (and confirmed with DOD documents) that SDIO had reached this same cost estimate, now unclassified, of $75 - $150 billion at least as early as June, 1987, by which time the

Defense Acquisition Board was aware of it. Apparently, SDIO chose to phase in the unclassified disclosure of the staggering cost estimate for Phase I.

In giving the CRS these estimates for Phase I, SDIO told them that for the most part they reflect "business as usual" and do not reflect reductions for extraordinary breakthroughs, efficiencies, management, or production techniques. The CRS says, "Launch costs, argues SDIO, are reduced in accordance with the expectations for the ALS."

This impression of a highly conservative cost estimate for Phase I is contrary to what DOD documents reveal. After briefings by SDIO personnel and many contractors over three months in 1987, and concentrating on Phase I, the Strategic Defense Milestone Panel said the following in an unclassified paragraph,

> "As a consequence of the current gaps in systems design and technology, none of the current cost estimates can be relied upon. They vary widely, even assuming that the current Phase I concept holds. By the time the necessary system and underlying technology work is complete, the design may change considerably and costs change as well."

Internal DOD documents reveal that the derivation of the $75 - $150 billion cost estimate was compiled from information supplied by five contractors. The contractors supplied their cost estimates for a "high cost" system and a "low cost" version. There was substantial variation in their estimates.

An example of the optimism contained in the $75 - $150 billion estimate is that an interim ALS was assumed to launch the great majority of the Phase I payloads and do so at less than one-third current launch costs. As explained elsewhere, there won't be any interim ALS.

It is very important to understand that this estimate of $75 - $150 billion is only for the demonstration and validation, full scale development, and deployment of Phase I elements. Omitted are the additional research costs SDIO would incur during that period for research on directed energy weapons, advanced sensors, advanced discriminators, and the kinetic energy weapons and BM/C3 not included in Phase I. For the period FY 1988 - 92 those additional research costs, which SDIO calls its "tech base costs" total over $28 billion.

No operation and maintenance costs for Phase I are included in the estimate. These costs are estimated to be $2 - 4.2 billion per year. In addition, the SDIO would pay only one-third of the cost of the technology and development for the Advanced Launch System for the years FY 1988 - 1992. The Air Force would contribute over a billion dollars

during that period.

Phase II deployment will be coming right on the heels of Phase I deployment. SDIO documents issued by Gen. Abrahamson on projected payloads for the Advanced Launch System anticipate a variety of directed energy weapons being deployed only two to four years after Phase I deployment. Thus, Phase I deployment costs will overlap the full-scale development costs for Phase II, and the demonstration and validation costs for Phase III. The combination will be a mind-numbing annual expense.

And it gets worse. One national laboratory study has estimated the life cycle costs of a second generation SDI defense at $541 billion. Life cycle costs for Phase I, using SDIO figures, could be as high as $171 billion. This suggests that the total costs for the first two phases of SDI could approach three-quarters of a trillion dollars.

8. BLURRING OF PHASES I & II

Deployment of a SDI Strategic Defense System is proposed in at least three phases, based on the maturity of relevant technologies, time, funding constraints and the Soviet threat.

Several factors are now combining to delay the date for Phase I deployment and to likely integrate at least one advanced weapon system into the late Phase I period, as well as at least one additional sensor. In sum, the line between Phase I and II is blurring. Budgetary and Phase I system limitations are driving this phenomenon.

Congress reduced the FY 1988 SDI budget request by $1.7 billion to a total of $3.6 billion. The Administration reduced its FY 89 request by $1.7 billion. For various reasons, this "reduction" forced SDIO to modify its budget such that there will be a delay of up to 2 years in the overall program schedule. Specifically the date for an "informed decision" on deployment will be slipped to [ ].

It should be stressed that SDI's use of the word "reduction" is based on comparing the FY 87 appropriation with the FY 88 request. Congress has reduced the SDI budget request on average about 30% annually. Thus there have always been "reductions" from the request. We believe the more significant financial comparison is actual appropriations year to year.

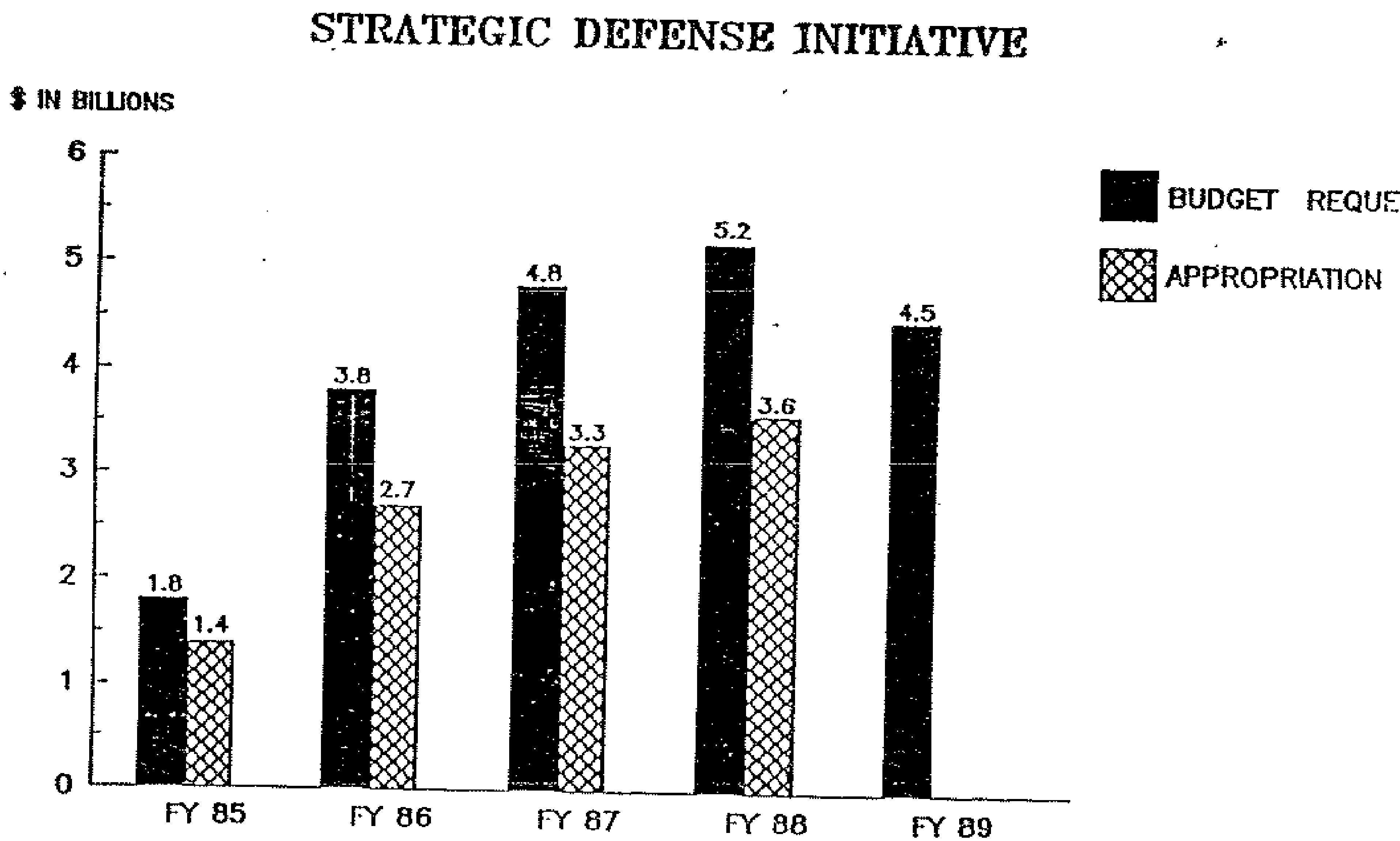
There have been no "reductions" in the annual SDI appropriations levels--only substantial increases (Figure 2). The SDI budget, including Department of Energy programs, sustained real growth of 56% in 1985, 79% in 1986, 19% in 1987, 5% in 1988, and the request for 1989 is 23% above the appropriations level for 1988 in real terms.

Nonetheless SDI argues, and we do not dispute, that the current budget levels will cause a restructuring of the Phase I program, increase the technical risk, and reduce the scope of testing for critical components.

In practical terms this means that the date for first deployment of the SBI component of Phase I, assuming the availability of launch vehicles, will be [ ] at the earliest with full operational capability three years following first launch. We believe this is a conservative estimate.

Last year the date for an informed decision on Phase I was FY 90. That was slipped two years to FY 92 prior to the restructuring of the FY 88 budget. Restructuring has caused further delay to [ ]. This sustained postponement of the informed decision date translates into actual deployment dates in [ ] time frame.

Figure 2



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The slippage in the initial deployment date for a Phase I program comes at a time when technical studies of SBI effectiveness are raising serious questions about its ability to survive modest improvements in the Soviet threat. One SDI contractor told us that the "Soviets can overcome (SBIs) in a timely and cost-effective manner."

These concerns flow from the increasingly realistic analyses of likely Soviet reactions to the SDI program examined in chapter 6. Given the high leakage rates projected for the current Phase I architecture, there is growing pressure to field a "rescue" weapon to save Phase I from anticipated Soviet responses.

Whether called an evolutionary or phased development, a gap-filler, force enhancer, or any other name, this pressure represents a signal that Phase I weaknesses are being recognized even within SDIO.

Phase I remains a flexible concept. It properly is designed to be reactive to the threat. We believe there is initial yet substantial evidence that the SDI community is moving to reinforce the Phase I plan of spaced-based and land-based interceptors with an advanced directed energy weapon--a space-based laser. This perception flows from the same set of concerns expressed earlier about a militarily significant Soviet reaction to SDI coupled with low operational effectiveness rates for the Phase I system.

SDI officials admit that they are "looking hard at the integration of directed energy weapons" and that "there is no other clear winner against a robust threat except chemical lasers--Zenith Star."

In the past year, chemical lasers have moved to the top of the option list as the preferred directed energy weapon for integration with SBIs. The case for space-based lasers has been driven by the need to intercept [ ] and fast burn boosters with multiple sophisticated decoys. It also has a role, at lower power levels, in midcourse discrimination.

In a form of self-fulfilling prophecy, SDI budget decisions have sacrificed research on FELs and NPBs while generally sustaining the chemical laser option. Comparing the FY 88 budget allocation to FY 87, the FEL was cut 16%, NPB 29%, directed energy weapon support programs 41%, while chemical lasers increased by 25%.

In the FY 1989 budget plan, chemical laser technology increases dramatically from $108.5 million (FY 88 appropriations) to $261 million--a jump of 141%. SDIO concedes this significant rise comes at a cost of slipping all DEW technology base programs by 12 months.

Competitors to Zenith Star-SBL have not fared as well in the FY 89 budget allocations. While the Free Electron Laser has proposed

increases of 47% from $155.5 million to $229 million, the program will be slipped 18-24 months. Key subsystem goals are being delayed or reduced in scope. The space-based experiment for FEL is planned for [ ].

The Neutral Particle Beam program suffers a 24 month slippage under the FY 89 budget. Funding increases from $102.6 million in FY 88 to $120 million or 17%. Primary emphasis seems to be placed on the Beam Experiment Aboard Rocket (BEAR) effort which will examine the operation of an accelerator in space and the propagation of particle beams over mission ranges.

While it cannot be argued that chemical lasers are on a crash schedule, clearly this portion of the budget has been protected to the greatest extent possible. The primary beneficiary of this strategy is the space-based laser experiment Zenith Star.

Zenith Star is an experimental test of a space-based laser system [ ]. The purpose of the test is to investigate [ ]. The experiment envisions the use of [ ] in an attempt to be consistent with the broad interpretation of the ABM Treaty.

Although Zenith Star is not fully defined and Treaty compliance issues have not been resolved, SDIO believes it is a good candidate for a space experiment since many of the components are nearly ready "to be bolted together and put up", as one headquarters official noted.

The absolute minimum schedule for Zenith Star is [ ] months with [ ] months being more realistic. In order to meet a responsive threat SDI officials believe that a decision to proceed with a fast paced schedule must be made in FY 1989 or FY 1990. The earliest on-orbit time for the experiment would be [ ].

Zenith Star would explore the operation of [ ].

The first objective of space tests would be to [ ]. The experiment will also assess the value of a laser as a [ ]. The issue is can enough energy be imparted to a target to [ ]? And lastly there will be an attempt to calibrate the quality of the beam using an aircraft flying at [ ]. This will determine [ ].

Certain science experiments would be performed on board. [

].
This could be useful in detecting [
]. The telescope might also test shifting capability by focusing on stars.

The cost of the Zenith Star experiment has not been estimated with precision but it will fall in the $1-$1.5 billion class. This includes the assembly of a one-time use booster.

The resurgence of interest in space-based lasers stems from new research on large mirrors; studies indicating that the polishing or hardening of missiles' skins is not as effective against a laser as once postulated; and some promising developments in phase conjugation which extrapolate into high power projections for large diameter phased arrays. In addition phased conjugation may allow the use of membrane mirrors with imperfect surfaces for more advanced systems.

At present the leading candidate for a space-based laser [.] which currently is being tested. A [ ] mirror is now being demonstrated but mirrors in the [ ] range will be required for an operational system. Some tracking and pointing data will be acquired in the Star Lab mission to be performed in FY 90 and a Relay Mirror Experiment is planned for the end of this fiscal year. While a deployed space-based laser will require [ ] megawatts of power, Zenith Star is in the [ ] megawatts range.

These comparative statistics make it clear that Zenith Star remains an experimental system rather than an initial deployable unit as SDIO agrees. FY 1989 funding calls for completing design review on Zenith Star and beginning preparation for ground tests. Milestone I for Zenith Star will be in FY 1990.

A space-based laser would provide capabilities for ICBM booster and PBV intercept and midcourse interactive discrimination. This discrimination would occur as lasers blow off the outer layers of heavy decoys or RVs and thus impart a change in the velocity of the target which could be measured and typed. Lighter decoys could be destroyed while others could be distinguished by thermal illumination.

It should also be noted that Zenith Star technology, even with one satellite, would provide "substantial" ASAT capability, according to an SDI advisory committee letter. This same letter stressed the need for 50% of the SDI/DEW budget to be allocated toward providing the data necessary to support an early milestone decision for a space-based chemical laser.

Several technology programs support the SBL concept. In addition to the [ ] mentioned above, Zenith Star will integrate technologies from the Large Advanced Mirror Program (LAMP), the Large

Optics Demonstration Experiment (LODE) dealing with beam control, and the STARLAB shuttle experiment.

The earliest potential initial deployment time for an operational space-based laser is [ ], according to the Air Force Space Division.

We have been told by several sources that General Abrahamson is pushing hard for the early demonstration of a space-based laser as a complement to Phase I. At our briefings at Air Force Space Division it was revealed that the Advanced Launch Vehicle program was directed to include a directed energy weapon in its launch program profile--a requirement to launch a package to low earth orbit of [ ] for the late 1990s or early 2,000s. The chemical components for this package were declared to be hydrogen and fluorine. This fits the description of a space-based laser.

It is not surprising that SDI officials are pushing for a space-based laser given likely Soviet responses and the limited utility of Phase I SBIs. Collocating a space-based laser with a field of SBIs provides protection not only by its ability to discriminate decoys but also its short range kill potential. Additionally, it makes possible the calculation of enforceable keep-out zones.

As one expert at a National Lab put it, "a deployed space-based laser (Zenith Star) would tell the Russians they cannot overcome a Phase I deployment with an evolutionary one step offensive response...Having Zenith Star in the wings forces the USSR to consider an arms control option."

The point we wish to make is that there are fundamental weaknesses in the SBI deployment scheme such that a space-based laser must be brought in to rescue Phase I--given evolutionary Soviet countermeasures. As the deployment time frame for Phase I stretches toward the year 2000, space-based lasers will become candidates for incorporation into the Phase I Plan.

SDIO is studying the synergistic effects between SBLs and SBIs. Initial calculations indicate that SBIs might be used to defend a SBL against direct ascent killers while the SBL assists by dramatically improving the kill rate of the SBI system against boosters and PBVs--either by providing discrimination or direct kill capabilities.

A second system also might benefit from the slippage of the Phase I deployment date--HEDI. Even though HEDI tests have been reduced from [

], then there could be a decision immediately following [ ] to incorporate this system into Phase I.

Finally it is possible that the Defense Acquisition Board may add the Ground Based Radar to the Phase I architecture plan.

9. SACRIFICING LONG TERM TECHNOLOGIES

Although SDIO asserts that they are carefully balancing the funding for near and long term technologies, the practical effect of recent budget decisions is to starve long term technologies in sacrifice for those systems which can be deployed relatively quickly. There is a strong bureaucratic imperative in this posture. As one SDI scientist put it in response to that observation, "a weapon is not a weapon unless it is deployed and a program without a weapon is no program."

The Congress has shown a keen interest in and support for continued research in exotic far term SDI technologies such as directed energy weapons. Last year Congress passed a Joint Resolution, section 8116 of the FY 1988 Continuing Appropriations Bill, that lays out the principles that should govern SDI in the future.

One key principle in that resolution said, "In matching research priorities against available resources, the primary emphasis of SDI should be to explore new technologies such as directed energy technologies which might have long-term potential to defend against a responsive Soviet offensive nuclear threat."

How does the current SDI program match up against that principle and the others contained in the Joint Resolution?

Certain overall budget trends are obvious. As a proportion of the SDI appropriation, Directed Energy Weapons funding has fallen every year since 1986 from 29.8% to 22.7%. Of the five major program elements under SDI, only Directed Energy Weapons sustained a reduction in funding from FY 1987 to FY 1988 (down $20.8 million or -2.5%). All other program elements increased in increments from 3.5% to 30%.

Comparing the FY 1989 request with the FY 1988 actual appropriations allocations confirms this emphasis on the deployable. As shown in Figure 3, SDI argues that Phase I projects will receive 14% of SDI funding under the FY 89 request compared to follow-on systems at 49.5% and dual use technologies at 36%. This conclusion assumes that BSTS, midcourse sensors, sensor technology, BMC3, the National Testbed, engineering support, survivability, lethality and key technologies, and the ALS all fall in the dual use category.

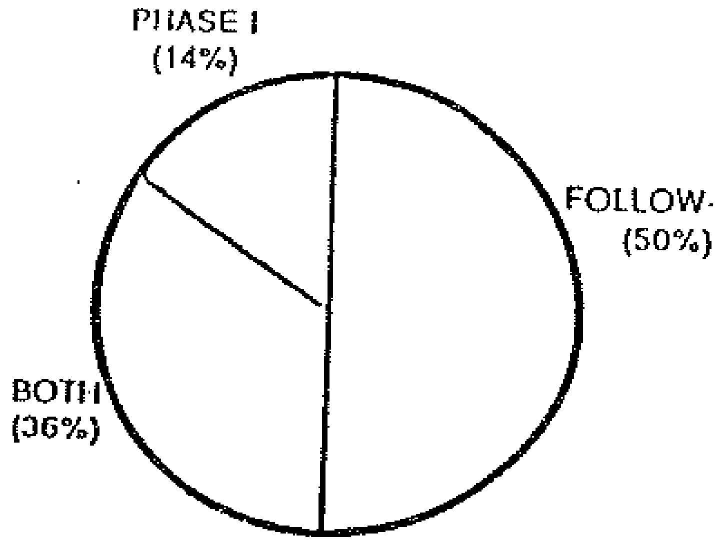
We believe that the great majority of dual use systems are dedicated to Phase I activities. Obviously these technologies could then be in place for exploitation in a Phase II deployment. But the

Figure 3

FY89 RESOURCE ALLOCATION ($M)

PROJECTS	PHASE I	BOTH	FOLLOW-ON PHASES
SATKA			
DSTS		179	
MCS		90	84
GBR			73
Sensor Technology		473	226
DEW			
SBL			180
GBL			201
NPB			67
ATP			153
DE Technology			429
KEW			
SBI	285		
ERIS	165		
HEDI			115
KE Technology	130		241
SA/BM			
BM/C^3 EXP		114	
NTB		115	
PHASE I ENGR	74		
ENGR SUPPORT		159	26
BM/C^3 Technology		131	21
SLKT			
ALS		72	
SLKT Technology		296	422
MGMT			
HQ		12	13

PHASE I	654
FOLLOW-ON	2251
BOTH	1641
	4546



key is that they are essential to Phase I. Our test of the proper definition is to ask, can Phase I be accomplished without the dual use systems? Where that answer is no, we believe they should be credited toward the cost of Phase I.

Using this definitional assumption, Phase I is consuming at least 50% of the annual SDI budget.

The only funding attributed to Phase I by SDIO is that for SBI, ERIS, some kinetic energy technology, and Phase I engineering. Phase I cannot function with only this set of technologies.

The programs listed in the dual use category are driven by SDI's objective of a Phase I deployment by the mid-1990s. If SDI had not committed itself to have hardware ready by the mid-1990s for deployment, then funding could be shifted from what amounts to engineering development and applied instead to research. There would be a large shift in funding from the dual use category toward follow-on phases.

It is doubtful that the SDIO list of follow-on phase technologies matches what Congress considers "promising new technologies which might have long-term potential to defend against a responsive Soviet offensive threat." For example, questions will surely arise about the inclusion of the ground based radar (GBR) which probably is going to be included in the Phase I architecture. Similarly, HEDI is a kinetic kill weapon that many believe would have great difficulty against a [ ]. The space-based laser essentially is the chemical laser which is being funded because of its near-term potential as a directed energy discriminator to support a degraded Phase I system.

An even split of resources between Phase I and follow-on systems does not mean there is balance in the SDI program except in the most basic mathematical sense. Near term deployment most likely will crowd out longer term research once hardware is being produced and launched. Then the cost curve shoots upward and unless there is a relatively open-ended commitment to funding, far term research will face severe budget restraints.

The emphasis on near term technologies is not surprising. It reflects the natural tendency of any bureaucracy to "get something out there" -- the ingrained preference for hardware over research. There is a fear at SDIO that Congress will use the "research" argument to in effect delay any deployment of Phase I. Thus there is an internal momentum to demonstrate and deploy. The scientists engaged in SDI research know this only too well. As one of them told us, "The ticket to getting more money is to go earlier".

We understand this natural tendency. There are many cases where

such an imperative is essential to national security. We note this phenomenon simply because it exists and must be recognized as a potent driving force in the SDI program.

The effects of the preference for near over long term technologies already are evident in program slippages. Cuts in the Free Electron Laser have caused a two year delay in that program--even though it has met all milestones in the last year. Experts at several National Labs and other government agencies told us that the reductions in FEL funding will have the inevitable consequence of making them look less attractive than the currently favored Zenith Star experiment.

The x-ray laser is a program with great promise but major technical hurdles to overcome. One of the nation's top SDI experts told us that the x-ray laser is a potent anti-SDI weapon: "If you don't like SDI", he said, "fund the x-ray laser because it is the best threat to SDI." The x-ray laser will require about $1 billion in investment to see if a first generation weapon is feasible in the 1991-1995 time period. It is not on this funding track at the present time.

The Neutral Particle Beam is considered an excellent system in the long term for interrogating and destroying rvs. It could be a boost/post boost electronics killer and a high traffic discriminator--with an ability to look at 100,000 objects. [

].

One NPB experiment, ISE or Integrated Space Experiment--a test against a cooperative target scheduled for 1991--has been cancelled. The ground test accelerator at Los Alamos will be operated at a minimum activity rate. These program reductions have occurred even though the NPB is meeting its technical milestones.

There is broad concern about the far term program slippages. A high ranking Air Force official told us in a private conversation "I worry about draining resources from the long term." He suggested concentrating more near term funding on surveillance and command and control before spending heavily on hardware--thus leaving room for energetic far term research.

The near-term/far-term debate is central to the future of the SDI program. There is no magic resolution of the issue since it involves competing missions, parochial interests, and policy preferences. SDIO leadership firmly believes the program is balanced. We find it increasingly biased for near term applications with the prospect of that imbalance damaging promising new longer range technologies.

10. THE UNDERESTIMATED SOVIET THREAT

Based on our briefings, it appears that SDIO is designing its Phase I space defense against an optimistic version of the Soviet threat. They appear to take a relaxed view of the smorgasbord of response options available to the Soviets to counter SDI. Phase I is being designed to address the Soviet threat of the mid-1990's, yet it probably will not even begin to be deployed until the late 1990's and will have the bulk of its deployment life in the following decade. The far more sophisticated threat environment of that later period would appear easily capable of defeating the Phase I system. In short, Phase I likely would be obsolete the day it was deployed.

The Baseline Offensive Threat: The fundamental threat document for SDIO is the [ ]. It is used to define the baseline threat that the SDI Phase I system would confront, both in terms of offensive missiles and the active and passive countermeasures that the Soviets might take.

[DELETED]

[DELETED]

[DELETED]

[

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[

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We heard from a number of scientists and analysts deeply involved in SDI research that Soviet programmatic responses would be quite possible in [ ]. Examples of feasible steps would be faster burning boosters, faster dispensing PBVs, [ ].

These scientists believe that such changes would fall into the categories of minor and major modifications. [ ]

[ ]

Given the fundamental threat that Phase I would pose to Soviet war objectives, responses at the early ends of the time periods would be more likely. And it is possible that the Soviets already have initiated activity to protect the option of deploying some of the lower-cost modifications.

As we have discussed earlier, it is very unlikely that Phase I can begin to be deployed by 1996, much less achieve a full deployment. Accordingly, it would make more sense to plan against the Soviet threat estimated for a fully deployed Phase I, or somewhere in the 2001-2005 time frame, rather than 1996.

[

] It is questionable to predict that in the face of US violation of the ABM Treaty through the deployment of Phase I or its testing, the Soviets would continue to restrict their offensive forces to conform with the limits of SALT I and II. SALT I would have expired 19 years earlier. SALT II never entered into force, and President Reagan repudiated both.

Even the higher SDIO figure [ ] appears modest, particularly when compared to other threat projections including those in the Defense Department's own publication, Soviet Military Power, the 1987 edition. The following Table 4 provides various threat estimates from [ ] Soviet Military Power (SMP 87).

TABLE 4

[ ]
[ ]

Estimate	Missile Warheads

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A number of people involved in the SDI program are concerned over SDIO's optimism about the Soviet countermeasures challenge. This questionable optimism is seen in the way SDIO briefed the [ ] threat to the DAB. SDIO concluded that [

]

[

]

SDIO has expressed frustration at responding to the "threat of the month club", as it sometimes refers to its critics. And certainly some of SDIO's frustration is justified: far from all of the countermeasures discussed by critics are feasible. Yet SDIO would be on firmer ground if it could, to borrow Senator Nunn's phrase, introduce a "cold shower of reality" into their threat assessment.

In SDIO's defense, it must be said they largely are dependent upon what DIA tells them, and we have seen that there are grounds to critique [ ] for Phase I. Perhaps these problems will be addressed in an updated Phase I [ ]

An important part of the problem may be the fact that the threat assessments being used are not developed by the Intelligence Community. Rather than seeking a coordinated interagency Intelligence Community assessment of the threat that would face the most costly and revolutionary complex of weapons systems in US history, SDIO is relying on the same process that would be used for a tank or tactical missile.

The threat is prepared by the DIA only, with assistance from Army Intelligence, the Army Strategic Defense Command, and the Air Force Foreign Technology Division. While some other elements of the Intelligence Community were consulted, it appears that important sectors of the Community were not. DIA alone has validated the [ ]

11. SDI and NATIONAL SECURITY: THE INSTABILITY FACTOR

In our many interviews and briefings with scientists, experts, and SDIO officials we found considerable confusion about how SDI and arms control fit together and about where SDI will take us vis a vis the Soviets. This confusion extends to the general public as well. SDI counts among its supporters several quite disparate groups, those who believe SDI is the path to clear superiority over the Soviets, those who believe SDI will maintain our nuclear deterrence, and those who think it will hasten arms control and mutual disarmament. On the other hand, many critics of SDI charge that if SDI proceeds on its current course it will exacerbate the arms race and lead us closer to nuclear oblivion.

Despite their confusion about where SDI is heading, all these individuals and groups probably agree on the key issue -- will SDI enhance our national security, although they might differ over a detailed definition of the term. SDI was offered to the American people as the best hope for assuring not only our Nation's security, but that of the world. To what extent has SDI established that it can enhance our national security? Where is it leading us?

It is not too early to expect at least partial answers. The program has enjoyed five years of funding at levels unrivaled by any other research program. Moreover, it is not just a research program now. With the Milestone One decision on September 18, 1987, SDI entered the demonstration and validation phase of the defense acquisition process, a key step on the way to production and deployment.

The Strategic Defense Milestone Panel itself, which reviewed SDI for the Under Secretary of Defense for Acquisition as a part of the Milestone I decision, wanted to know if moving to Phase I deployment of strategic defenses would in fact enhance our national security. They posed the question as follows. If we deployed Phase I and the Soviets followed our example (as the President has recommended) and deployed an equivalent system, would we be any more secure than if we had never deployed Phase I in the first place? The Panel discovered that no satisfactory analysis has even been conducted on the issue. Disturbed at the absence of any such analysis, the panel recommended that such a study be conducted.

When we asked the appropriate SDIO officials in mid-March about whether such an analysis was underway, they responded that SDIO was "just in the process of kicking off a study on that now." They elaborated that the Soviets likely would respond with a ground-based system, and they "probably could not match our deployment schedule for

a space-based system". They said the U.S.likely would deploy later phases of SDI before the Soviets responded with a space-based system. Another SDIO program manager agreed that "mutual occupancy" of space by both the U.S. and the Soviets is not a realistic scenario during the Phase I time frame.

[

DELETED

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We found this to be the general view of SDIO officials and contractors and indicative of the direction in which SDIO is proceeding. They well know the importance of a space-based, boost-phase defense for any comprehensive ballistic missile system. Their objective is to have the technology available to get there first and stay ahead of the Soviet response to Phase I.

Wherever it is going, this scenario is not moving in the direction of the President's vision for SDI. Phase I and the expected Soviet reaction move in the opposite direction from what the President proposed. The plans for SDI phased deployment anticipate that it will prompt the Soviets to respond with countermeasures in an effort to defeat strategic defenses. The President's concept was to convince the Soviets to adopt SDI-like defenses.

When SDI was first initiated, President Reagan presented it as a dramatic alternative to the threat of massive nuclear retaliation. SDI would replace this concept with a world of defenses so effective as to make offensive nuclear weapons "impotent and obsolete". In his vision, defenses rather than offenses ultimately would predominate.

Some important aspects of President Reagan's vision have been overlooked. Just six days after the President's SDI speech he told reporters that once it were proven effective, a later President "could offer to give that same defensive weapon to them [the Soviets] to prove to them that there was no longer any need for keeping these missiles."

President Reagan also wrote on December 28, 1984, "And in the long-term we have confidence that SDI will be a crucial means by which both the United States and the Soviet Union can safely agree to very deep reductions, and eventually, even the elimination of ballistic missiles and the nuclear weapons they carry."

In that first SDI speech the President recognized that if only one superpower possessed effective defenses it would destabilize the arms race: "If paired with offensive systems, they can be viewed as fostering an aggressive policy, and no one wants that."

Under these circumstances, the defensive shield would be perceived as the means to blunt the retaliatory capability of the opponent. The opponent would lose confidence in its deterrent capability, creating enormous incentives for the opponent to try to overcome those defenses and for his adversary to prevent that. President Reagan clearly articulated the necessity of both sides having defenses if an era of strategic defenses is to be a stable condition. This is why he has indicated on several occasions his willingness to provide (give or sell) defensive technology to the Soviets.

This assumes that the United States would consider the elimination of nuclear missiles to be a desirable goal, a debatable assumption. If effective defenses were also to exist against bombers and cruise missiles, we may only be making the world safe for conventional war, a kind of warfare in which the Soviets would have distinct advantages.

If the President's vision is not where SDI is moving, upon what path is the Administration trying to take us? It has not been easy to tell. From President Reagan's terse comment, "SDI is arms control," to the rash of conflicting statements by Administration officials as to whether SDI is or is not a bargaining chip, it is not easy to discriminate policy from rhetorical chaff.

A direction or path has now emerged in the SDI documents submitted to Congress. A plan is discussed candidly in the Report to Congress on the Strategic Defense System Architecture (January, 1988). In summary, the Administration wants the threat of SDI phased deployment to induce the Soviets to agree to deep reductions in offensive nuclear missiles. Even if they agree to such arms control measures, SDI still would be deployed as an "insurance policy", but coping with a constrained threat will require less extensive improvements to Phase I.

If the Soviets refuse our arms control offers, then SDI will be deployed anyway and improvements in successive phases will be as extensive as needed to address the Soviet unconstrained threat. Either way, Phase I would be deployed. The promised land of a defense - predominant world will have been achieved either by treaty or through technological might.

The ABM Treaty of 1972 creates two critical barriers to this plan. First, the Administration acknowledges that the Treaty's ban on testing and development of space-based ballistic missile defense systems inhibits the U.S. from making SDI technology look credible to the Soviets, thus diminishing SDI's leverage at the arms control table.

Second, the Treaty prohibits deployment of SDI, even if it is what

the Administration would label "an insurance package". It would be awkward for the U.S. to invoke Article XV of the Treaty and withdraw from the Treaty on the grounds that events have "jeopardized its supreme interests", if the Soviet Union had just agreed to deep cuts in offensive missiles.

The Administration's response to these obstacles has been to invoke the so-called "broad interpretation of the ABM Treaty," which permits testing and development of <u>exotic</u> ballistic missile defenses.

To hurdle the second obstacle the Administration insists that any START arms control package must in effect permit SDI testing, development, and later <u>deployment</u> of SDI after a specified period of time. Otherwise, SDI will in effect have been only a bargaining chip in the arms talks, an option foreclosed long ago by the President's repeated assertions to the contrary. Once SDI deployment is permitted, then the ABM Treaty will have been nullified.

It is easy to see why SDI is a stumbling block to progress on START. It is not easy to see why the Soviets would agree to such a proposal, particularly with respect to amending the ABM Treaty to permit general deployment of ballistic missile defenses. As one SDI scientist has said, "I have yet to see an explanation as to why it's to the Soviets' advantage to agree to defenses."

<u>Will Phase I Escalate the Arms Race?</u>

Numerous aspects of this arms control strategy are cause for concern. Chief among them is that the Administration seems to have ignored the question of how Phase I would affect arms control stability.

The Administration has dodged the question repeatedly. In the <u>Report to Congress on the Anti-Ballistic Missile Treaty</u>, (May 19, 1987), the Administration in an unclassified portion of the report seems to ignore the possibility that the Soviets might respond by escalating the arms race. The report says:

> " A stronger SDI program, made possible by the broad interpretation of the ABM treaty, could reduce more rapidly Soviet confidence in the future capability and value of their ballistic missiles. This could enhance the near-term prospects for substantial, equitable, and verifiable reductions in ballistic missile forces.
>
> "In addition, the Soviets cannot be expected to negotiate arrangements for a jointly-managed transition to a balance of offensive and defensive

> forces if they perceive that the chances of a strategic defense ever being deployed by the United States are slim, either because of domestic political opposition or lack of technical confidence. Restructuring the SDI program to demonstrate quickly and convincingly the technical feasibility of effective defenses against ballistic missiles would have the salutary effect of dashing Soviet hopes that, if they just wait long enough, the United States will take care of their SDI problem for them, free of charge. With this avenue closed to them, and with SDI gaining credibility as an important component of the future U.S.-Soviet strategic relationship, serious negotiation is likely to emerge as the only acceptable avenue left open to them."

Congress specifically requested in section 226 of the FY 1986 Defense Appropriation bill that the Report to Congress on the SDI include a section on possible Soviet responses to SDI. Instead, the reports to Congress for 1986 and 1987 describe the process by which SDIO set up Red teams and Blue teams and how they interact. Neither report discusses the possibility that the Soviets might respond to SDI by substantially increasing the number of their offensive warheads.

In the few instances where SDIO elsewhere discusses the possibility of Soviet proliferation of offensive weapons, the matter is dismissed with assertions that SDI will be cost-effective, so the Soviets will not choose to adopt a strategy of offensive proliferation.

For example, Sen. Bennett Johnston submitted a question in advance to Gen. Abrahamson for a hearing held on March 31, 1988, requesting that he discuss how SDI would affect arms race stability. General Abrahamson responded:

> "As the Administration has defined an effective strategic defense system, it will have the effect of discouraging the Soviet Union from responding with offensive countermeasures and/or proliferation of offensive forces. Against effective defenses, the best response is a corresponding defense. Realization of this by the Soviet Union would enhance the prospects for a strengthened US-Soviet arms control regime."

Of course the Soviet countermeasures and proliferation program will begin well before we deploy SDI and before the Soviets know exactly what our system will be.

It is disturbing that the role of SDI in enhancing our national security is so confused five years after the program's inception.

Certainly the SDIO response on arms race stability ignores the history of the arms race. As one retired Air Force general told us, when the Soviets increased their strategic defenses (Tallinn Line), we responded with deployment of more missiles and MIRVed missiles. We didn't rush to negotiate away our bombers and missiles.

The End Game: Living in an SDI World

Despite SDIO's assumption that Phase I deployment will be unilateral, one has to consider what would happen in the long run if both the United States and the Soviet Union developed the technology for extensive ballistic missile defenses. Once we either abandon or amend the ABM Treaty to permit such deployment, turning back will be difficult. Where will SDI lead us in the long run? Is it a stable world such as the President has portrayed? Is there a stable path to that world?

The Fletcher Report is one place we have found where these questions are clearly addressed. This seven volume roadmap for SDI research devoted only two pages to the subject of "Stability During Evolution to Space-based Defense Strategy", but those two pages demolish the idea of stability in such a situation.

Among Fletcher's "Major Conclusions" were:

> "The mutual occupancy of space by both sides is potentially an unstable situation..."

Only three exceptions were noted. The first was if one or the other side (U.S. or U.S.S.R.) controls space. That is, one side would force a space denial policy on the other. The second exception was if the satellites of each side are invulnerable to each other because of hardening or deception. The third exception was if neither side could successfully execute a preemptive attack on the other's defenses because the time required for such an attack is sufficient to enable the opponent to protect his defenses.

In arriving at this conclusion Fletcher used three scenarios. In one, the United States is the first to deploy a complete and effective space-based boost-phase intercept system, thus giving us an "overwhelming strategic advantage" over the Soviet Union. In another case, the situation is reversed. In both cases the "other nation" regards the situation as "unacceptable" and attempts to destroy the opponent's system during deployment. The nation having the defense attempts to limit the other nation's access to space in order to ensure the survivability of its defenses.

The third scenario involves the mutual occupancy of space. It is assumed that both sides possess extensive defenses equipped with directed energy weapons that can attack at the speed of light. According to the Fletcher report, what ensues is a "high noon" shoot-out in space. Each side is capable of using its defensive weapons in space to attack the other's defenses, and both sides realize that with speed-of-light weapons, the first side to shoot wins. The only exception is if the defensive weapons and critical sensors can be made [ ] invulnerable. Rather than being the peaceful and highly stable world often portrayed by Administration officials, this "whoever shoots first, wins" world of mutual occupancy of space virtually defines the word "unstable" in a strategic concept.

The reason for this extremely unstable situation is that directed energy weapons (DEW) in space are expected to be even more effective against satellites (including space-based SDI systems) than they are against ballistic missiles. As for making DEW and space-based sensors undetectable, it would be extremely difficult to hide them in orbit against the cold backdrop of space. Similarly, making any space-based object invulnerable or superhard is a daunting task indeed, especially against the nuclear weapons or nuclear pumped x-ray weapons being considered for the future.

The "he who shoots first, wins" scenario was the view in the Fletcher report in 1984 regarding the far-term mutual occupancy of space situation. How far has SDIO come in wrestling with this problem since then? One SDIO program official speculated that eventually we could make battle stations in space survivable enough to accomplish the SDI mission, even if attacked by an opposing Soviet SDI constellation. However, another SDIO official said when asked about the mutual occupancy of space problem, "I assure you we have nightmares over it."

It is important to realize that neither we nor the Soviets rationally would abandon nuclear deterrence, dispose of our nuclear weapons, and rely on our strategic defenses alone, unless we or they were totally confident (100%) of the effectiveness of our respective defenses. That confidence level includes the survivability of the defenses. Obviously, if the defenses of one side could be attacked and destroyed by the other, or at least rendered even partially ineffective in its defensive mission, the opposing side could dominate the other with only a handful of nuclear weapons.

Even if we continued to rely on nuclear deterrence, mutual possession of SDI-type defenses would diminish our confidence in our deterrent capability. After all, an SDI defense would be more effective in defending against a ragged retaliation than against a first strike. The Soviets might be expected to have a similar view of the matter.

In answers submitted for a hearing on March 31, 1988, Gen.

Abrahamson said that SDIO had examined the mutual occupancy of space issue in the Future Security Strategy Study, which was chaired by Fred S. Hoffman, and submitted to the President in October, 1983. That study indeed says defensive systems can increase stability, but adds "we must not allow them to be vulnerable." Stability could decrease, we are warned, if the defenses lose their effectiveness against large attacks, and if the defenses are superimposed on vulnerable offensive systems. In particular, the study says, "Boost-phase and mid-course layers may present problems of both vulnerability and high sensitivity to attack size."

Some SDIO program officials fully appreciate the importance of solving the vulnerability problem. The detailed budget justification sheets submitted in February, 1988, with the FY 1989 SDI budget request repeat the f llowing quote from the Fletcher report,

> "assessment of the vulnerability of responsively hardened targets to lasers, particle beams, and x-ray weapons is the single most important issue in determining whether there is a feasible concept for development and ultimate deployment of a Strategic Defense System".

Added is the statement, "This remains true today." While these SDIO officials appreciate the importance of vulnerability, SDIO does not appear to appreciate that until the issue of vulnerability is resolved, strategic defenses offer no prospect for stability.

SDI's Impact on U.S. Offensive Weapons Development

There also appears to be no sense of historical perspective within the Administration on the interaction between offense and defense. Those wondering what a world with robust U.S. and Soviet SDI systems deployed would look like need look no further than the superpowers' experience in the strategic bomber arena, which has a rich history of over 40 years. Both the U.S. and Soviet Union had extensive air defenses deployed by the late 1950s, yet neither side had any assurance that those defenses could achieve more than modest attrition of hostile bomber forces.

This situation, coupled with the advent of the ballistic missile, which was unaffected by strategic air defenses, led the U.S. largely to abandon strategic air defense in the early 1960s. After 25 years of intense Soviet research and deployment of air defenses, the Air Force still has high confidence that the great majority of its bombers can deliver their weapons to their targets.

As General John Chain, CINCSAC, recently put it in his colorful

way, "The probability of our getting through the other side is pretty damn good." Many believe that the Soviet investment of hundreds of billions of dollars in air defense has been largely for nought -- as demonstrated most recently by U.S. development of the Stealth bomber.

The trends continue to be adverse for Soviet air defense, with the U.S. using a combination of tactics (e.g., flying low to avoid Soviet radar), offensive deployments (threat proliferation through the use of cruise missiles), passive countermeasures (decoys, chaff, etc.), and active countermeasures (radar jamming, anti-radiation missiles, defense suppression missiles) to largely negate Soviet air defense capabilities. It should be noted that these are the same kinds of techniques that would be useful in responding to strategic missile defenses.

The bomber experience should also teach us about the impact of defenses on arms control negotiations. New Soviet developments in air defenses did not encourage the U.S. to sharply restrict or throw away our bomber forces in the Geneva negotiations. In fact, quite the opposite happened. In the SALT II negotiations, a key U.S. objective was to protect the air-launched cruise missile program, which was properly seen as important to maintain our bomber fleet's ability to penetrate Soviet air defenses in the late 1980s and beyond. In both SALT and START, the U.S. has strongly resisted Soviet attempts to ban ALCMs, or to have them counted the same as ballistic missiles.

In much the same way, U.S. efforts to develop and deploy missile defenses are more likely to encourage the Soviets to protect options they would need to offset those defenses than to encourage them toward sharp reductions in their missile forces.

An excellent example of what could happen to U.S. offensive force requirements in an era of unrestricted strategic missile defenses is in our submarine-based ballistic missile (SLBM) force. The six SLBMs the U.S. has developed in the last 30 years are shown in Figure 4. The shorter range Polaris A-1 was replaced by the somewhat longer range Polaris A-2. The A-2 was replaced by the still longer range A-3, which also had multiple warheads (though not independently targetable) and other penetration aids specifically designed to counter Soviet ABM efforts.

The A-3 was followed by the Poseidon C-3, a major advance over previous SLBMs. This highly MIRVed missile (capable of carrying up to 14 warheads) gave us a major capability to saturate Soviet missile defenses. It was followed in production by the Trident I C-4 SLBM, whose longer range resulted in a ten-fold increase in ocean area available to submarines within target range, further adding to their survivability. Finally, this was followed by the Trident II D-5 missile, whose accuracy, range and warhead yield are such that it has virtually all the capabilities of the MX ICBM.

FLEET BALLISTIC MISSILES

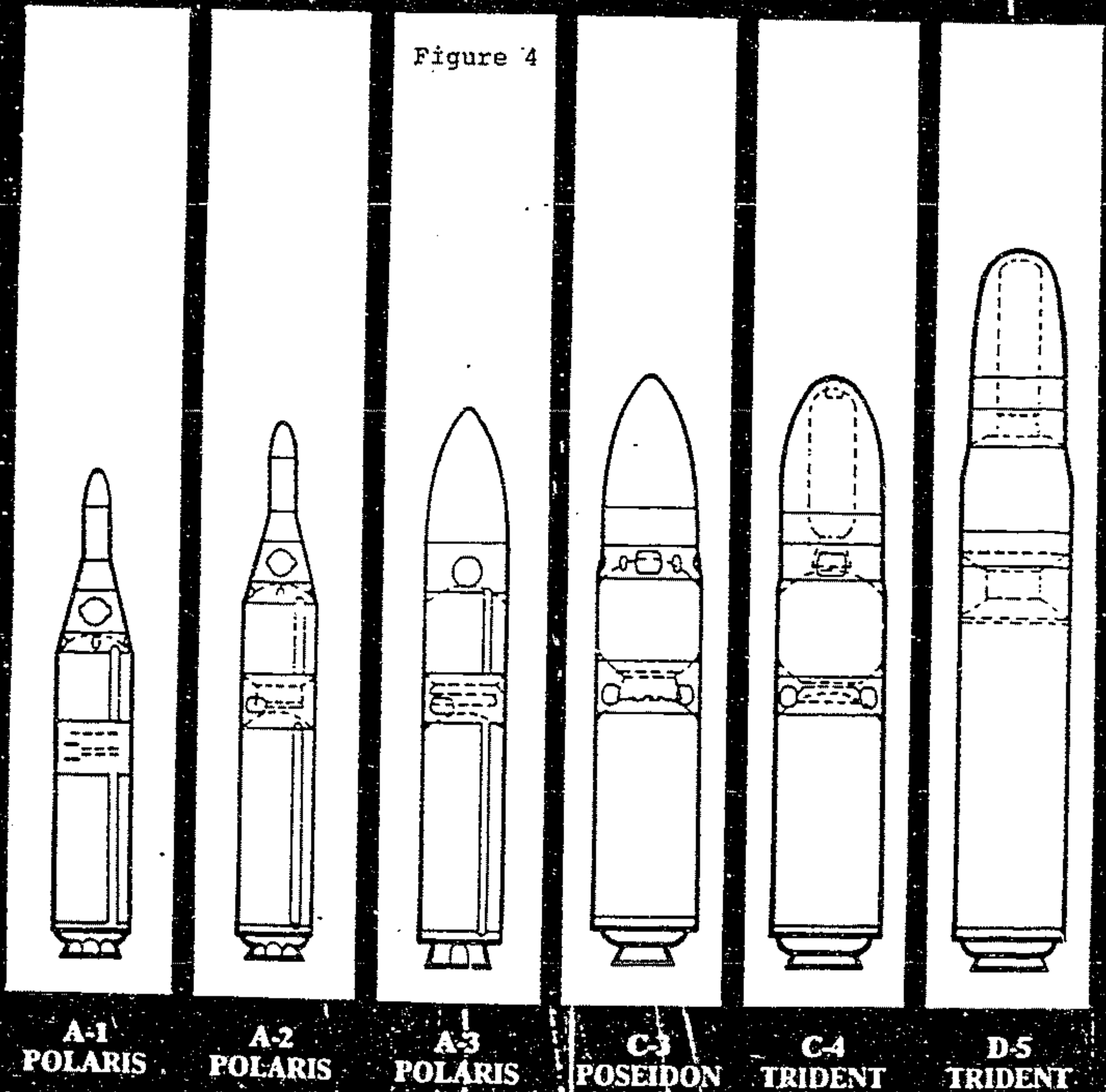

Figure 4

Since the mid-1950s the U.S. continuously has been developing new types of SLBMs -- until today. For the first time in over 30 years the U.S. has no R&D program for a follow-on "Trident III" SLBM. This remarkable development in the history of the superpower arms competition has somehow been overlooked. When asked why there was no Trident III R&D program, a senior Navy official asked us, "What the hell else do you want a new SLBM to do" that the Trident II can't do? The Trident II has all the accuracy needed, and future improvements can be incorporated into the current missile. The existing missile also has the space and weight reserve required to accommodate the penetration aids for defeating a terminal ABM system if the Soviets choose to deploy one.

It is significant to note that the Navy proposed to develop a [ ] Trident II full-scale engineering development program, but this was rejected by the Secretary of Defense because there was no need for it. [ ] would be an excellent countermeasure to a Soviet ABM system, and in fact the [ ] was developed for the Trident I, though it was never deployed. Given the thin Soviet ABM defenses and the lack of clear evidence that the Soviets intended to break out of the ABM Treaty, Secretary Weinberger turned down the Navy proposal for the Trident II [ ] though it is an option should the Soviets expand their strategic defenses.

The Navy believes that Trident II can cope with an expanded Soviet terminal ABM system with changes in the payload alone, [ ] However, the senior official confirmed that the Navy's lack of a requirement for a "Trident III" would certainly change if the Soviets were to deploy their own space-based SDI. In that circumstance, the Trident II -- even though it has some inherent features that would make it difficult for a Phase I-type of SDI system to be effective against it -- could not be changed enough to cope with the new threat, and a new SLBM would be needed.

In other words, the ABM Treaty has brought us to the place where it may be a long time before we need a new type of SLBM, if ever. But proceeding with SDI would undo this, as the need to maintain an offensive deterrent would force us to develop new missiles able to cope with Soviet defenses. The same situation would likely apply to ICBMs as well in a few more years. Unless there is a fundamental change in the national security objectives of both sides, deploying SDI would restore a dangerously destabilizing dimension to the arms race that would stimulate offensive responses that would not be needed in the absence of SDI.

12. NITZE SDI CRITERIA

The Congress has established two statutory certifications which must be met prior to the deployment of any SDI system: survivability and cost effectiveness at the margin. The language of these requirements was patterned after the assertions of the Administration's senior arms control advisor, Ambassador Paul H. Nitze. These conditions have been endorsed by the Administration.

Three years after public announcement of these conditions, SDIO only now is developing a comprehensive methodology for cost-effectiveness. That work has not yet been completed. Thus absolute statements about Phase I cost effectiveness, such as those made by General Abrahamson on March 5, 1988, appear to be premature at best. We cannot make an absolute statement to the contrary, but after extensive consultations with experts in the SDI program, we believe that deployment of the Phase I architecture would be unlikely to meet the test of either certification.

With Phase I deployment over a decade off, our cost effectiveness conclusion must be premised on matching SDI system characteristics as presently known to reasonable expectations of the Soviet threat in the same time frame. Of course this opinion may change over time both as the Phase I deployment plan hardens into technical and financial reality and the Soviet response to SDI takes a more visible form.

It is important tc recognize that the survivability and cost effectiveness calculations are necessary but not sufficient predictors of Soviet behavior. Faced with a fundamental threat to their national security, the USSP will take whatever responses are required--costs notwithstanding. Their commitment to massive air defenses is such an example--where they poured more funding into air defenses than the U.S. spent on its offensive bomber force.

The origin of the Congressional criteria for deployment of an SDI system rests in a speech given by Mr. Nitze to the World Affairs Council in Philadelphia on February 20, 1985. Mr. Nitze, then as now, a senior arms control advisor, stated:

> "The technologies must produce defensive systems that are survivable; if not, the defenses would themselves be tempting targets for a first strike. This would decrease, rather than enhance stability.
>
> New defensive systems must also be cost-effective at the margin, that is it must be cheap enough to add additional defensive capability so that the other side has no incentive to add additional offensive capability

to overcome the defense. If this criterion is not met, the defensive systems could encourage a proliferation of countermeasures and additional offensive weapons to overcome deployed defenses, instead of a redirection of effort from offense to defense.

As I said, these criteria are demanding. If the new technologies cannot meet these standards, we are not about to deploy them."

This statement became a benchmark by which the SDI program is measured within the Department of Defense and by Congress. In this sense the Nitze criteria are the most important legal and technical challenges facing the SDI program, with the possible exception of the ABM Treaty.

The Reagan Administration officially endorsed the Nitze criteria in a State Department report which stated in part:

"Within the SDI research program, we will judge defenses to be desirable only if they are survivable and cost effective at the margin.... If a defensive system were not adequately survivable, an adversary could very well have an incentive in a crisis to strike first at vulnerable elements of the defense. Application of this criterion will ensure that such a vulnerable system would not be deployed and, consequently, that the Soviets would have no incentive or prespect of overwhelming it.

Our cost-effectiveness criterion will ensure that any deployed defensive system would create a powerful incentive not to respond with additional offensive arms, since those arms could cost more than the additional defensive capability needed to defeat them. This is much more than an economic argument, although it is couched in economic terms. We intend to consider, in our evaluation of options generated by SDI research, the degree to which certain types of defensive systems, by their nature, encourage an adversary to try simply to overwhelm them with additional offensive capability while other systems can discourage such a counter effort. We seek defensive options which provide clear disincentives to attempts to counter them with additional offensive forces."

The Nitze criteria also were endorsed by SDIO Director Lt. General James A. Abrahamson in testimony before the Senate Armed Services Subcommittee on Strategic and Theater Nuclear Forces on October 30, 1985:

"We will not proceed to development and deployment unless the research indicates that defenses meet strict criteria: Within the SDI research program, we will judge defenses to be desirable only if they are survivable and cost-effective at the margin."

It is important to note that General Abrahamson believes these twin tests should be statisfied before moving into full scale development on an SDI system.

The Congress enacted the Nitze criteria into permanent law in 1985 in the Department of Defense Authorization Act of 1986 (P.L. 99-145). The original amendment was introduced in the Senate by Senator William Proxmire and was accepted without dissent after discussions with the Chairman and Ranking Member of the Senate Armed Services Committee. The provision, which is part of permanent law, states:

"A strategic defense system developed as a consequence of research, development, test, and evaluation conducted on the Strategic Defense Initiative program may not be deployed in whole or in part unless--

(1) the President determines and certifies to Congress in writing that--

(A) the system is survivable (that is, the system is able to maintain a sufficient degree of effectiveness to fulfill its mission, even in the face of determined attacks against it); and

(B) the system is cost effective at the margin to the extent that the system is able to maintain its defense at less cost than it would take to develop offensive countermeasures and proliferate the ballistic missiles necessary to overcome it; and

(2) funding for the deployment of such system has been specifically authorized by legislation enacted after the date on which the President makes the certification to Congress."

The Senate and House Conferees stated that deployment of individual systems would be permitted even though they might be components of a future SDI system if their primary purpose was not strategic defense at the time of deployment. An example might be sensor satellites.

These legal requirements pose such severe problems for the Phase I

deployment plan that the SDI office has attempted to dilute the meaning of this Congressional mandate by redefining its terms and by suggesting that this language is not binding.

In May of 1986 General Abrahamson was quoted by the New York Times as saying:

> "The reason that many people, including us, were worried about cost-effective at the margin is for the fundamental principle: we are trying to get the Russians to modify their behavior.... There may be many reasons for wanting to make a positive judgment that we can or cannot go forward. And it shouldn't be our criteria; it should be our best judgment about what will produce the best results for our nation both in terms of Soviet behavior and our capability.... (The Nitze standard) shouldn't be defined so narrowly as to preclude a deployment that would be sound for other reasons."

The effort to deflect the impact of the Nitze criteria took specific form in 1986 when the annual report from SDIO stated that an SDI system should be deployed if it meets four conditions:

Potential role in US strategy

Deterrent to surprise attack and enemy escalation

Contribution to our arms control objectives

Technical Feasibility.

This 1986 report failed to list cost-effectiveness as a condition of deployment even though Congress enacted it into law the prior year. The term "affordability" was used as a economic standard in its place. Affordability is a useful constraint, but it treats neither the cost of Soviet countermeasures nor the survivability of our own system. It is an inadequate substitute for cost-effectiveness.

When SDIO was criticized for this omission, it subsequently mentioned cost-effectiveness as a requirement. For example, in a May 1987 report to the House and Senate Armed Services Committees, SDIO states that "technology and tactics must be available that would allow the system to evolve over an extended period to counter any plausible responsive threats...This criterion is couched in terms of cost-effectiveness at the margin; however, it is much more than an economic concept."

The closing caveat that cost-effectiveness at the margin "is much

more than an economic concept" is often repeated in official documents and not by accident. It is designed to stress an argument that the measuring of cost-effectiveness must take into consideration non-quantitative techniques of analysis. This gives SDIO some maneuvering room. An example of a non-quantitative factor they have cited is leverage in arms control negotiations.

The law requires cost-effectiveness to be certified by the President for deployment of an SDI system in whole or part. Thus the calculation must be made for Phase I and all subsequent deployment phases. It will not be an easy task to accomplish but making such calculations prior to a development decision is critical to an informed decision by Congress.

SDIO currently is developing a framework for analyzing cost effectiveness in the SDI context and we applaud this initiative.

General Abrahamson stated this year that while difficult to calculate, the cost advantage to the United States of a Phase I deployment could be "factors of 1.5, 2, maybe even higher." This conclusion must be based on preliminary data as SDIO still has a contractor developing a cost effectiveness methodology.

We have reviewed a number of contractor and national laboratory system studies showing cost trade-offs of a Phase I deployment. Several are strongly at odds with General Abrahamson's claim.

We have not performed any detailed cost-effectiveness calculations of our own. However, some of the "snapshots" of the larger picture for Phase I cost-effectiveness concern us. We note that in the FY 89 budget request the Navy is seeking $1.87 billion for 66 Trident II missiles or $28.4 million per missile. If the Soviets could build a silo-based version of the Trident by the turn of the century, then the cost of a silo and nuclear devices for the eight RVs would add only about $20 million at most, yielding a total systems cost of $50 million. This rough calculation appears to create a negative cost-exchange ratio favoring the offense over SBI.

The Trident II's boost-phase is so short (about 170 seconds) that SBI would have almost no capability against it. Although Trident II's post-boost phase is long, it can be reduced substantially. If we assume that an SBI CV would have a 90% absentee ratio against a Trident II with a modified PBV, and that each CV had 10 SBI's on board, then even if the SBI's were 100% effective, the cost would favor the offense in this situation unless CVs could be produced and boosted into space for $50 million or less.

The cost figures [ ] report suggest it is unlikely that a [ ] could be built this inexpensively. Other factors obviously must be taken into account, but this "snapshot"

raises questions about Phase I cost-effectiveness.

We were told in several briefings by SDIO and contractor officials that it would cost several hundred billion dollars for the Soviets to rebuild their missile forces to cope with Phase I. [

] And they could build 2,000 Trident II's for $57-$100 billion if they can duplicate our cost situation in the future. These figures further heighten our doubts about the Phase I cost-effectiveness case.

Despite SDIO's confident assertions that SDI will be cost-effective, Congress should understand that there is no accepted cost-effectiveness methodology at present to support such statements. And we have seen preliminary system studies with cost exchange data quite unfavorable to Phase I that cannot be dismissed. For the time being Congress should maintain a healthy degree of skepticism about assertions of Phase I cost-effectiveness.

13. THE "RED SHIELD"

In arguing the virtues of its SDI program, the Reagan Administration has continued to raise the specter of a Soviet SDI program, nicknamed "Red Shield", that dwarfs U.S. efforts. Just last month President Reagan said,

> "The Soviet defense effort, which some call "Red Shield," is now over 15 years old and they have spent over $200 billion on it -- that's 15 times the amount that we have spent on SDI."

This statement is seriously misleading. Such an estimate includes Soviet expenditures for air defense against bombers and cruise missiles and for anti-satellite applications, as well as strategic defenses against ballistic missiles.

There is no doubt that the Soviets have been quite active in ballistic missile defense research and there has been limited development and deployment of terminal ABM systems -- those systems that are targeted on the last segments of the ballistic missile flight trajectory. However, there is a major difference between their orientation and a full SDI program. The latter of necessity must be a multi-tiered approach, as the U.S. SDI program is, composed of a variety of sensor and weapons platforms based on the ground and in orbit. The Soviet "SDI" effort lacks this broad focus.

There is a reason for the special character of the Soviet ballistic missile defense program. [ ] the entire Soviet ABM program is devoted to protecting the Soviet leadership. Given that the Soviet leadership can be concentrated in a relatively few locations, point defenses are a logical way to protect them. General population protection demands comprehensive area defenses. The Soviet ABM program is thus consistent with a leadership protection mission. To the extent that the Soviets have a population defense, it is based on an offensive strategy: preempting an adversary's attack by destroying his missiles before they are launched.

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] The Soviets are conducting some research on FEL and other ground-based lasers, x-ray and space-based lasers, particle beam technologies, and related systems. [ ] "currently there is no evidence to

indicate a Soviet lead over the U.S. in chemical lasers for space weapons."

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While the Soviets are making a significant investment in BMD research, it has neither the breadth, sophistication, nor objectives of the SDI program. Like many aspects of Soviet life, the "Red Shield" is reserved for the Soviet elite.

Nevertheless, this situation is by no means static. If the U.S. presses development and deployment of Phase I, the Soviets could be expected to follow, pursuing their own SDI system, along with several asymmetric responses.

14 14 SCALING THE ALPS: DEFENSE AGAINST ACCIDENTAL LAUNCH

Over the three decades in which strategic missile defense has been debated, one recurring idea with particular appeal has been the deployment of a modest defense designed to protect against an accidental Soviet launch. Such a defense also often is viewed as having utility against an attack by a third country. This justification was used by Defense Secretary McNamara in 1967 when he proposed the "thin" Sentinel ABM system to defend the US against an attack by the Peoples Republic of China, and it has been used from time to time in support of the SDI program.

This question has been raised anew by Senator Sam Nunn (D-Ga), in a speech he gave this past January before the Arms Control Association in Washington. His position as Chairman of the Armed Services Committee in the Senate and the authoritative role he plays in many national security debates guarantees that this concept will receive close examination for months to come, as it should.

In his speech, he called upon the Reagan Administration to "take...a cold shower of reality" on arms control, and took it to task because "in the five years since SDI was launched, the Reagan Administration has consistently substituted slogans for objective and technically sound explanations...SDI has been treated as a theology rather than a scientific research program." This set the background for Senator Nunn to urge the U.S. to "seriously explore the development of a limited system for protecting against accidental and unauthorized launches." Such a system would be consistent with the ABM Treaty, although modest changes might be necessary.

The Accidental Launch Protection System (ALPS) has not been precisely defined, but basically it would consist of 100 ERIS launchers based at Grand Forks, North Dakota, the one site allowed under the 1974 Protocol to the ABM Treaty. The interceptors would be housed in the Sprint and Spartan silos remaining from the Safeguard system that briefly was deployed there in the mid-1970's.

ERIS missiles would be guided by radar to the general vicinity of the targeted RV where they would home in on infrared radiation. ALPS would utilize an upgraded version of Safeguard's Perimeter Acquisition Radar (PAR). Later versions of ALPS could use AOA sensors, and HEDI missiles could replace some of the ERIS interceptors. The ALPS missiles would intercept the incoming RV either late in the midcourse phase or, in the case of HEDI, in the early terminal phase. As a result, the errant missiles would have full opportunity prior to interception to dispense their multiple warheads plus any decoys and other countermeasures with which they might be equipped.

Lockheed estimates the cost of an ALPS deployment at $3.55

billion, a figure often used in public discussions. This cost is broken down as follows:

Research and Development	$1.03 Billion
Production	0.79
Operations and Support	0.35
Radar and Other Modifications	0.82
Program Management and Reserves	0.56
	$3.55 Billion

Another organization with substantial experience in ballistic missile defense argues that the cost of an ALPS providing a minimum credible defense capability is over $16 billion. Full operational capability would not be reached in this system until 1995. This minimum system is more costly than Lockheed's because of the inclusion of Probe/GSTS, the AOA, and ten years of Operations and Support costs.

In addition to the minimum system, a high quality ALPS was described which would cost $37 billion. The high quality system is similar to the minimum system but also includes HEDI, a much more capable BM/C3 system, and a new ground based radar rather than radar upgrades. The greater expense of the high quality system largely is due to the additional sensors capability.

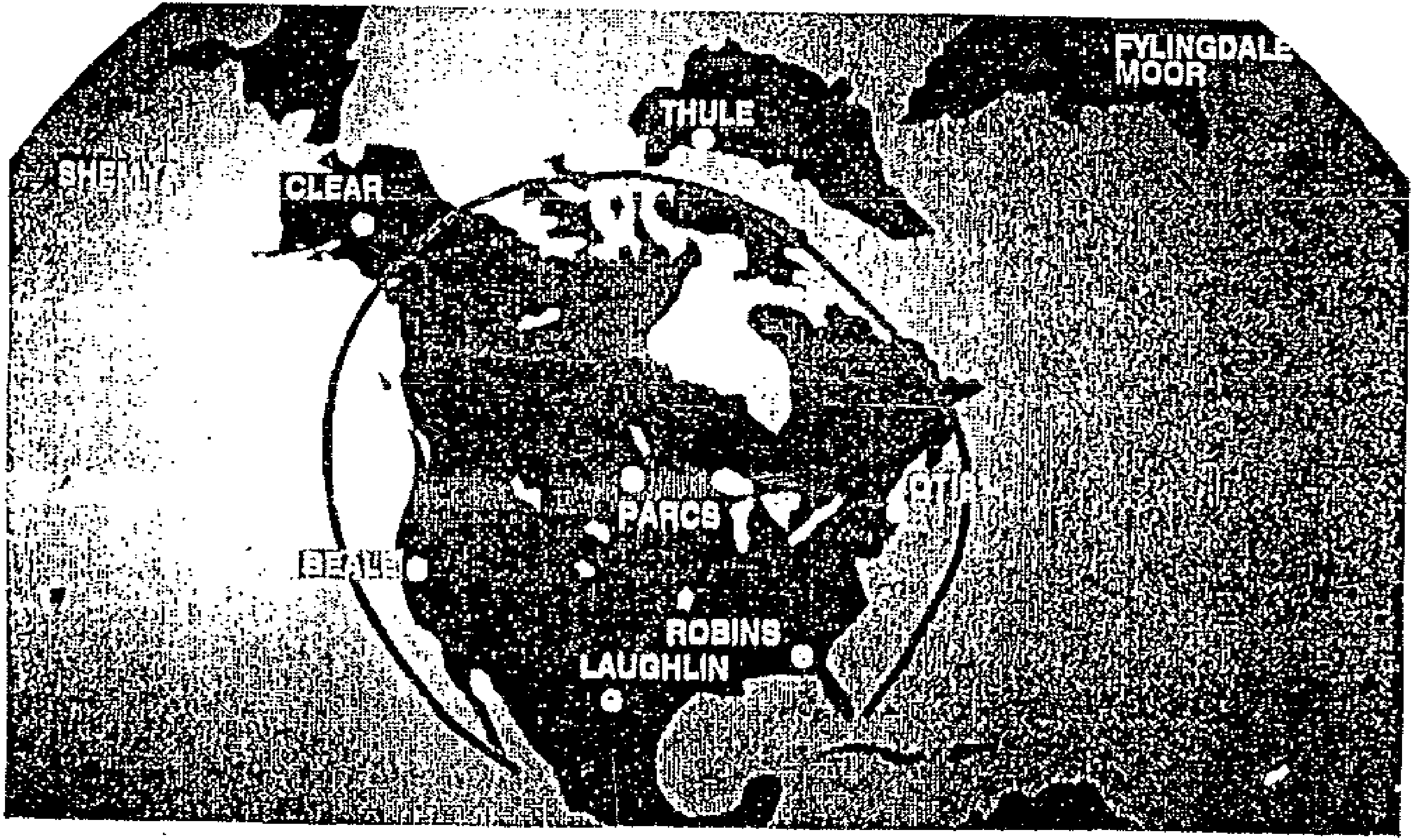
Two points are evident. First, the estimates of cost for an ALPS system vary widely. These cost estimates should be carefully evaluated by Congress. Second, adding sensors and battle management capability to cope with the possibility of Soviet decoys drives up the cost of ALPS considerably.

Some modifications to the 1972 ABM Treaty may be necessary, depending on the level of protection sought. The one site at Grand Forks in theory would allow for full coverage against an accidental Soviet launch of ICBMs as shown in Figure 5. It would be ineffective against an accidental launch of shorter range, or depressed trajectory, SLBMs because of their shorter flight times. In the latter case, shown in Figure 6, the coastal regions of the continental US, with about 48% of the American population, would still be vulnerable. Full protection against SLBM attack would require at least two more bases, which are banned by the Treaty.

There could be a problem with the Treaty's prohibition on nationwide ABM defenses, of which ALPS would be a thin version. Furthermore, ALPS may use early warning radars in ways that are inconsistent with the ABM Treaty's restrictions on such radars. If both the US and USSR approved, the Treaty could be modified to permit parallel ALPS-type coverages.

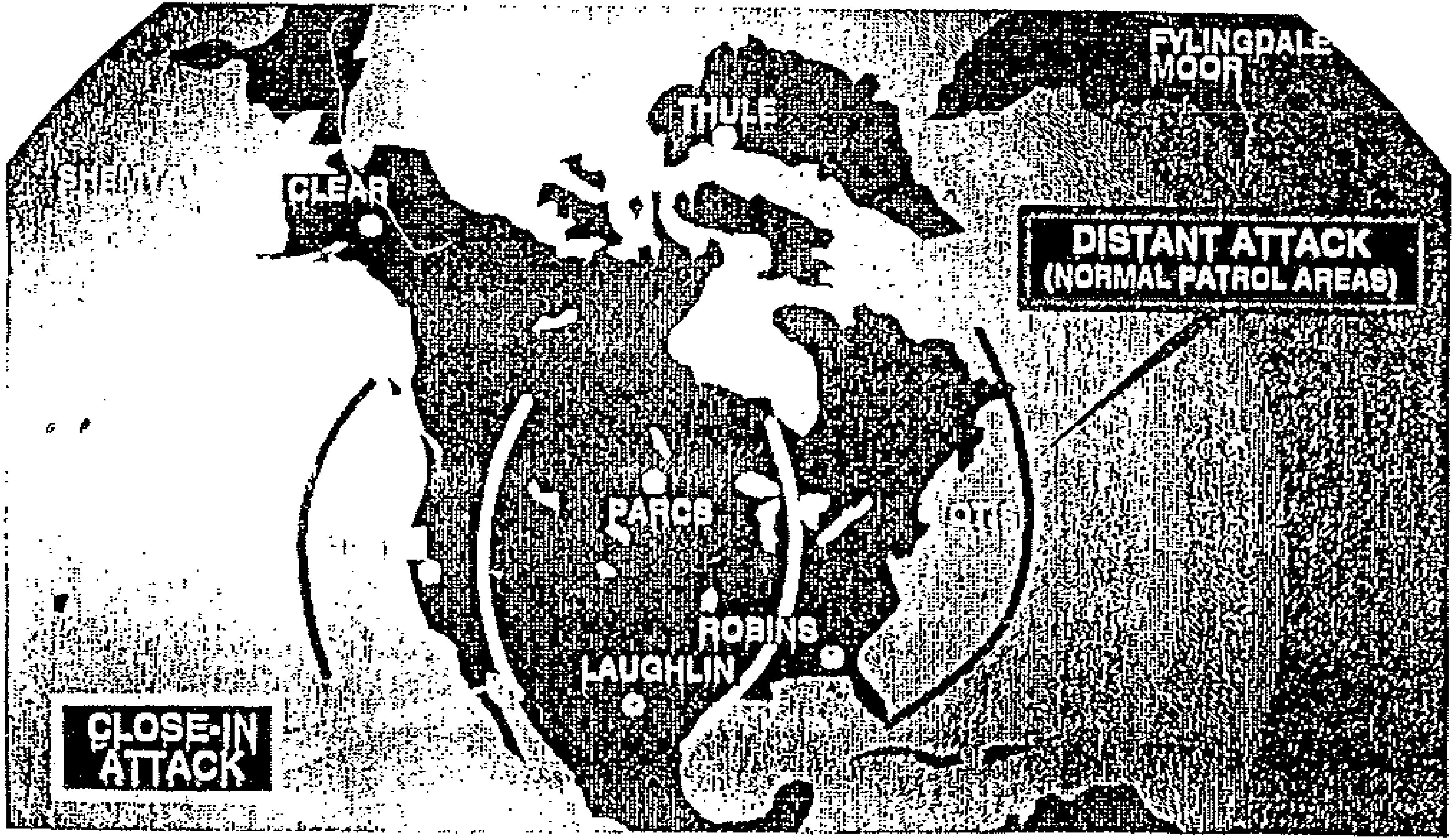
DEFENDED FOOTPRINT - ICBM THREAT

Figure 5



DEFENDED FOOTPRINT – SLBM THREAT

Figure 6



Several basic questions must be addressed in determining whether a system such as ALPS is desirable. The answers will require substantially more study. Some of the most important questions are:

1. What is the threat ALPS will be designed for, and how realistic is that threat?

2. How effective would it be, both initially and over time? Are there more effective ways to accomplish the same ends?

3. Would funding ALPS detract from more urgent national defense priorities?

4. Would the Soviets interpret ALPS as a precursor to a full SDI deployment?

In defining the threat ALPS will be designed for, it is important to distinguish between accidental and unauthorized launches. Accidental launches are those that arise from the malfunction of hardware or software and are not the result of a conscious human decision. Unauthorized launches are those that result from intentional human decisions and actions which bypass the procedural safeguards.

In looking at the strategic forces on both sides, there are few if any instances where an individual or group of individuals controls just one nuclear warhead, or even one missile. Soviet submarine officers have control over the launch of up to 20 missiles with up to 160 warheads. ICBM launch control officers usually have responsibility for 10 missiles.

Therefore, an unauthorized launch might well involve the firing of more than one missile. If the individuals involved knew that an ALPS system existed, they might launch more than they otherwise would to ensure destruction of the target. It is thus possible that an ALPS system could yield more destruction from an unauthorized launch than if there were no system at all.

If more than a few MIRVed missiles are launched, an ALPS based on 100 interceptors could be strained to the breaking point. And if the missiles in question have decoys, this effect is multiplied. Accordingly, a number of strategic defense specialists believe that ALPS would be of only very limited value in defending against unauthorized launches.

The challenge of decoys could be countered by adding a discrimination capability to the ALPS framework. Even assuming that midcourse discrimination is possible, about which there is much technical disagreement, it would significantly increase the cost of the ALPS. There would be one special advantage: the survivability of the

sensor platforms would not be an issue for ALPS, as it is for SDI. Adding a sensor suite to ALPS most likely would violate the ABM Treaty's restrictions on mobile sensor platforms.

ALPS faces a fundamental problem. It would not be effective against missiles equipped with decoys and other countermeasures to any significant degree. Yet if the Soviets believe that ALPS was a precursor to the deployment of Phase I, they would simply add countermeasures to their missiles.

In short, a vigorous pursuit of Phase I appears to be incompatible with the ALPS concept.

Another ALPS issue is whether a non-nuclear interceptor such as ERIS is the appropriate missile given the ABM Treaty's 100 interceptor limitation. If a decision is made to provide the US with accidental launch protection, nuclear-armed interceptors could be one option. A kinetic kill interceptor such as ERIS can destroy only one object while a nuclear-tipped interceptor can clear out a wide expanse of space.

Some may object to using nuclear interceptors because it would result in nuclear detonations over North America. This overlooks the fact that if the Soviets use salvage fuzing in their warheads, there would be a nuclear explosion no matter which type of interceptor was involved. A salvage fuze automatically detonates the warhead if it abruptly decelerates, as when struck by a kinetic interceptor. On the other hand, when the warhead on the nuclear interceptor detonates, the intense radiation destroys the salvage fuze before it can trigger the incoming missile warhead. Therefore, an ALPS architecture might want a mix of nuclear and non-nuclear interceptors.

ALPS would not provide a perfect defense. According to recent Congressional testimony by Lockheed and McDonnell-Douglas, a Treaty-compliant ALPS would allow [ ] of incoming warheads to reach their targets.

Whatever level of protection ALPS might offer, it likely would provide an anti-satellite capability superior to the recently terminated F-15/MHV ASAT program. ERIS would have a substantial capability against all but the highest altitude satellites.

ALPS deserves further study. It appears, however, that it will be more costly and potentially less effective than widely perceived. Proceeding with Phase I appears to be incompatible with the ALPS concept.

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LIST OF ACRONYMS

ABM	Antiballistic Missile
ALS	Advanced Launch System
AOS	Airborne Optical Sensor
ASAT	Antisatellite
BM/C3	Battle Management/Command, Control, and Communications
BSTS	Boost Surveillance and Tracking System
C3	Command, Control, and Communications
CINC-SD	Commander in Chief-Strategic Defense
CONUS	Continental United States
CSOC	Consolidated Space Operations Center
CV	Carrier Vehicle
DAB	Defense Acquisition Board
DEFCON	Defense Condition
DEM/VAL	Demonstration/Validation
ECM	Electronic Countermeasures
ERIS	Exoatmospheric Reentry Vehicle Interceptor System
EW	Electronic Warfare
GBL	Ground Based Laser
GBR	Ground Based Radar
GSTS	Ground Based Surveillance and Tracking System
HEDI	High Endoatmospheric Defense Interceptor
HVG	Hypervelocity Gun
ICBM	Intercontinental Ballistic Missile
JCS	Joint Chiefs of Staff
LCC	Life Cycle Cost
MWIR	Medium Wavelength Infrared
NCA	National Command Authorities
NMCS	National Military Command System
NPB	Neutral Particle Beam
NTB	National Test Bed
NTF	National Test Facility
OMV	Orbital Maneuvering Vehicle
OTV	Orbital Transfer Vehicle
PBV	Post Boost Vehicle
PENAIDS	Penetration Aids
P3I	Preplanned Product Improvement
ROC	Regional Operations Center
RV	Reentry Vehicle
SASS	Space Assets Support System
SATKA	Surveillance, Acquisition, Tracking and Kill Assessment
SBI	Space Based Interceptor
SBKKV	Space Based Kinetic Kill Vehicle
SBL	Space Based Laser
SBSP	Space Based Support Platforms
SCP	System Concept Paper
SDIAE	SDI Acquisition Executive

LIST OF ACRONYMS (Con't)

SDIO	Strategic Defense Initiative Organization
SDS	Strategic Defense System
SDS-CC	Strategic Defense System - Command Center
SDS-OC	Strategic Defense System - Operations Center
SLBM	Sea Launched Ballistic Missile
SSTS	Space Surveillance and Tracking System
SWIR	Short Wavelength Infrared
TBM	Tactical Ballistic Missile
TW/AA	Tactical Warning and Attack Assessment
WWMCCS	World Wide Military Command and Control System